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THE IRON AGE

OCTOBER 15, 1936

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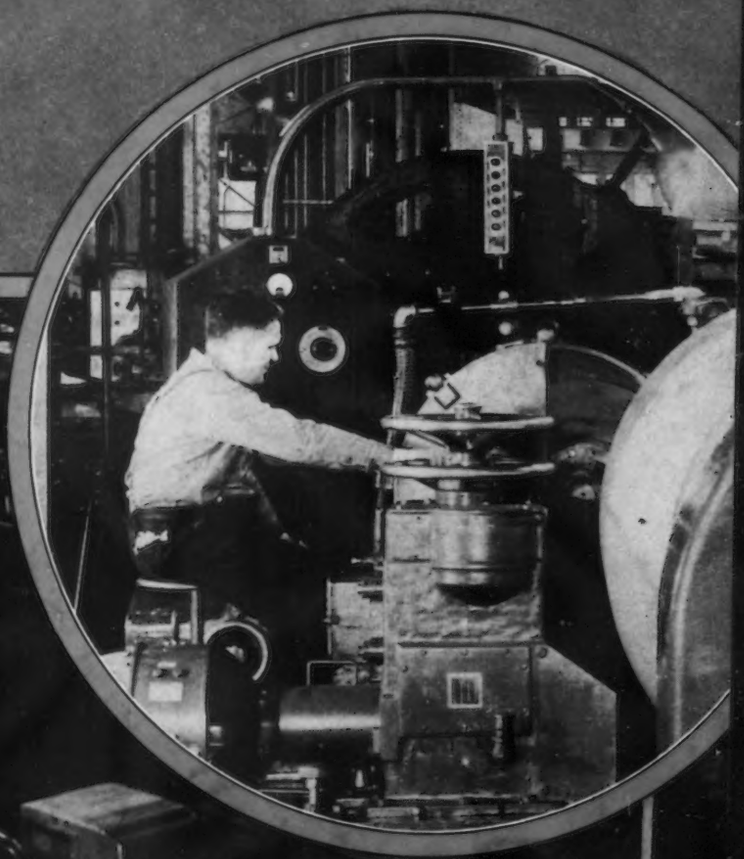

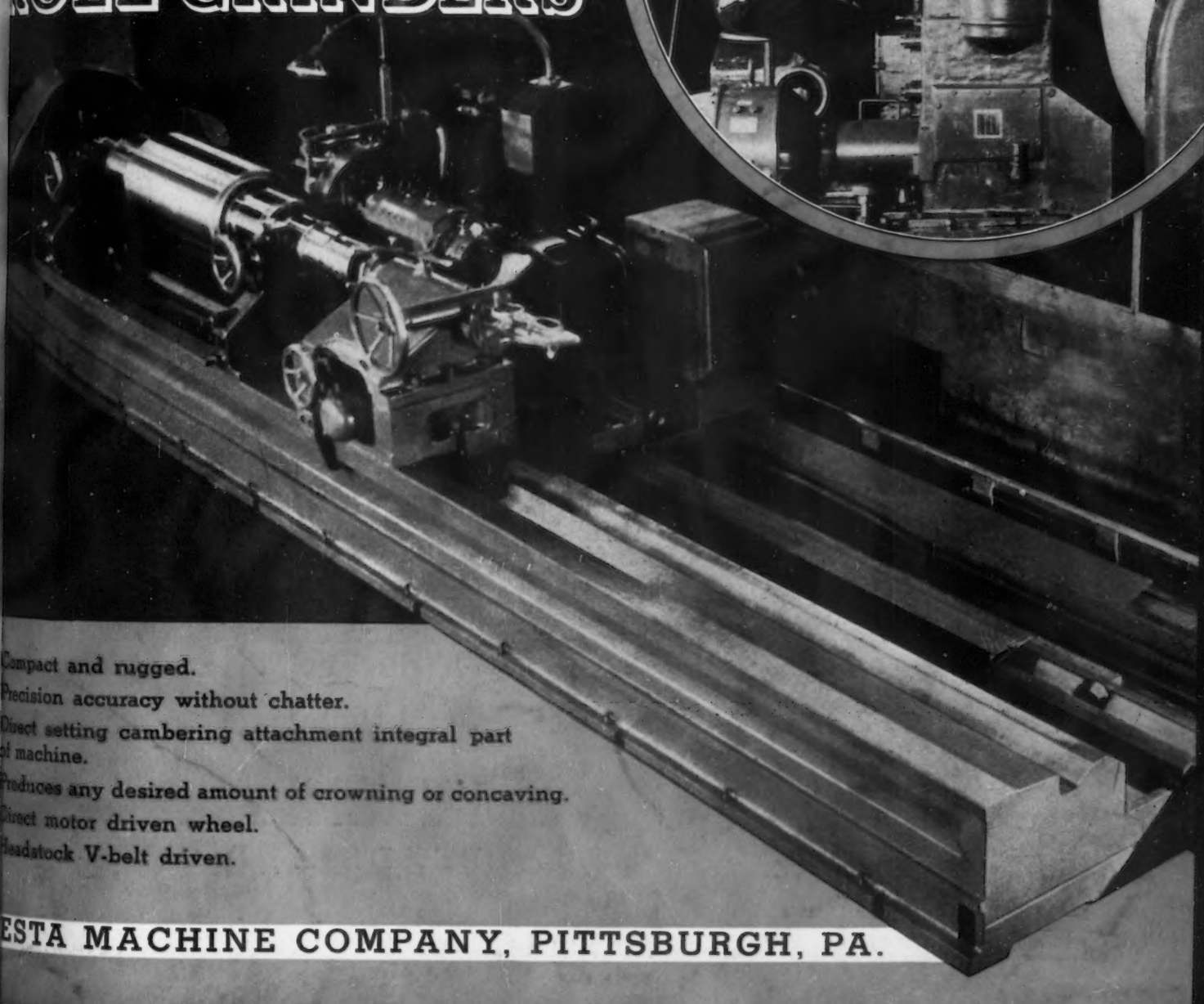

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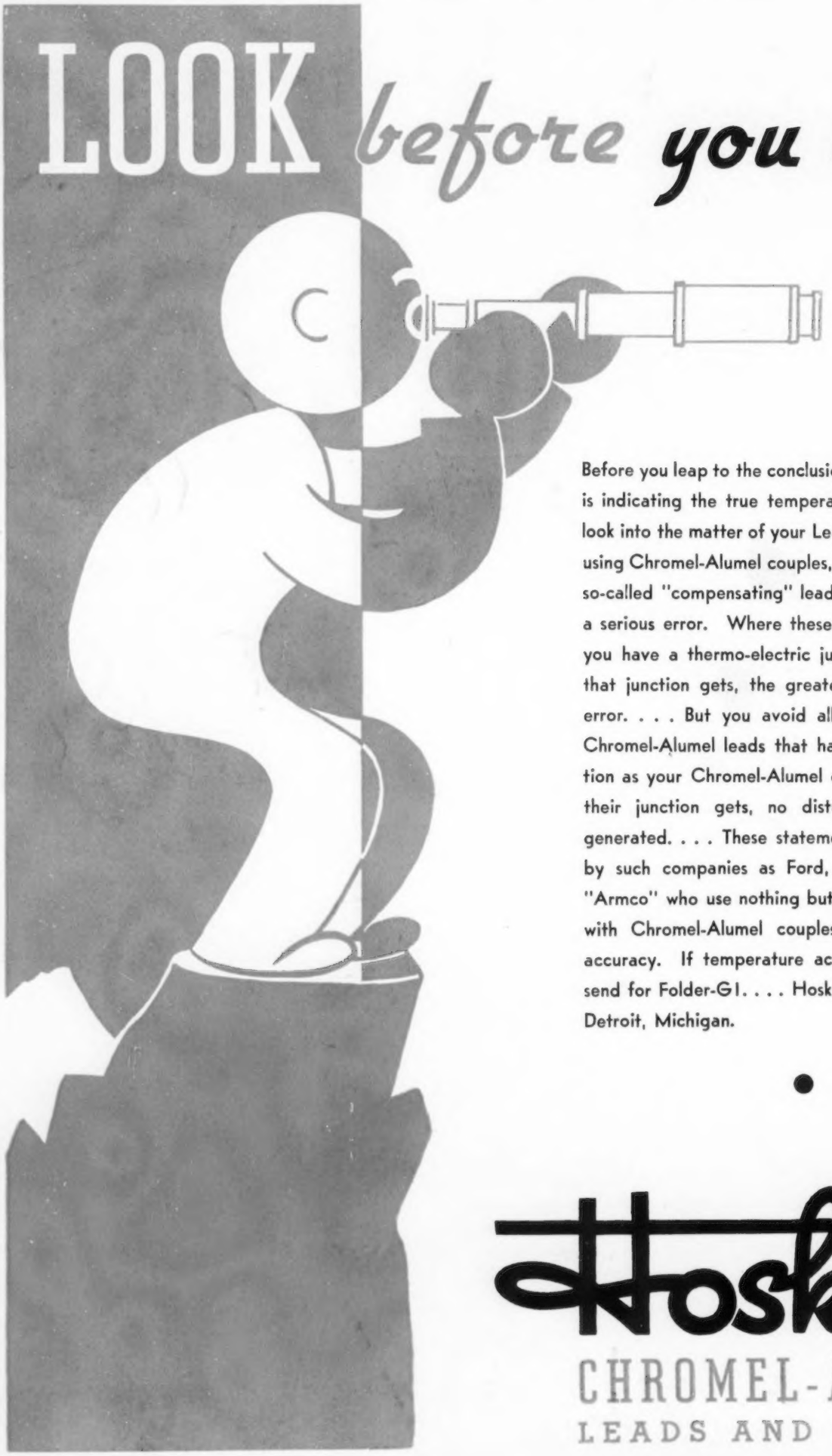

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THE IRON AGE

CHESTNUT AND 56TH STREETS, PHILADELPHIA, PA.
Sales Offices
239 WEST 39TH STREET NEW YORK, N. Y.

Eighteenth National Metal Congress Issue

THE IRON AGE wishes to express its appreciation to Climax Molybdenum Co. for furnishing and permitting the use of the photographs reproduced in this issue on pages 47, 161 and 199. The photo on page 99 was furnished by Margaret Bourke-White, that on page 145 was supplied by Richard T. Dooner, Philadelphia, and the one reproduced on page 79 was furnished through the courtesy of Lincoln Electric Co.

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Indexed in the Industrial Arts Index.
Published every Thursday. Subscription Price: United States and Possessions, Mexico, Cuba, $6.00; Canada, $8.50, including duty; Foreign $12.00 a year. Single copy, 25 cents. Cable Address, "Ironage, N. Y."

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THEY PUT THE STAMP OF APPROVAL ON LAST YEAR'S METAL SHOW

• Metal men from all over the U. S., from nearly every foreign country, poured into last year's National Metal Congress & Exposition. 17,344 registered and proved to their own satisfaction that this great Metal Show is the most important event of the year.

They came with a thirst for metal knowledge. They went away with the latest news of metal progress . . . learned first-hand at the exhibits of hundreds of manufacturers . . . learned in technical sessions addressed by leaders in the metal industry . . . learned in conversation with new friends and old.

This year, five great national Societies are cooperating to present the eighteenth annual National Metal Congress & Exposition in Cleveland's huge Public Auditorium. Technical programs are the most comprehensive, the most complete in the history of the Metal Congress. More than 175 metal experts have cooperated to prepare 107 talks dealing with production, selection, fabrication, testing, inspection, treatment, welding and application of all kinds of metals.

And the Congress is only part of the attraction. Another part is the Metal Exposition where two hundred manufacturers will present at least 24,273 items with regard to materials, methods and equipment used in the metal industry. Many exhibits will be in actual operation. You may compare and consider, at one time and in one place, the equipment in which you are particularly interested.

Rest assured, you will see the greatest Metal Show on earth. You will have opportunity to exchange ideas with leaders in your field . . . will have a chance to renew old friendships.

The 17,344 metal men who visited last year's Show will tell you this is the most important metal event of the year—and 17,344 can't be wrong. The Show opens Monday the 19th. Write or wire for hotel reservations now—be on hand for the first day.

NATIONAL METAL SHOW

CLEVELAND, OHIO — PUBLIC AUDITORIUM — OCTOBER 19-23, 1936

COOPERATING SOCIETIES

AMERICAN SOCIETY FOR METALS — AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEER
AMERICAN SOCIETY OF MECHANICAL ENGINEERS — AMERICAN WELDING SOCIETY — THE WIRE ASSOCIATIO

I AM very happy to extend to the readers of THE IRON AGE a most cordial welcome to attend the National Metal Congress and Exposition to be held in Cleveland, Oct. 19 to 23, 1936.

The Congress, sponsored by the American Society for Metals, in cooperation with the American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, and American Welding Society (holding simultaneous but separate sessions) will be the most important meeting on metals held for many years.

An outstanding feature of the American Society for Metals technical sessions in the past has been the symposiums, particularly those on nitriding and grain size, and, this year, in addition to other very important papers by the country's most famous metallurgists, a two-day symposium will be held on the working of metals.

A series of educational lectures will again be presented during the Congress, the title this year being, "The Physical Testing of Metals."

Another outstanding paper to be presented by the American Society for Metals is the Campbell Memorial Lecture, "High Speed Steel Carbide Segregate and Grain Size."

The exposition, which this year will have a greater variety of exhibits than ever before, will be one of the largest in the eighteen-year history of the Society. Practically every product, process and type of equipment used in the metal industry will be displayed in the Public Auditorium, where the exposition will be held.

We take pleasure in extending to all the readers of THE IRON AGE a sincere and cordial invitation to attend the convention and exposition.

R. S. ARCHER

President, American Society for Metals

Eighteenth Annual . . . . Four

THE technical meetings held by the societies participating in the National Metal Congress are of particular value to industry. The forthcoming gathering at Cleveland will bring together groups interested in progress in metals and their application to machines and equipment. The great handicap to progress is the often slow introduction of new developments into practice, but as in previous years, the Metal Congress will aid tremendously in overcoming this handicap. The participation this year of the American Society of Mechanical Engineers is especially significant in that we will join with the American Welding Society in a symposium that will bring to engineers a series of papers and discussions which will give them a useful guide on welding practice. To readers of THE IRON AGE we suggest that they attend the symposium, and examine all the other timely scientific papers being sponsored by the Society of Mechanical Engineers.

WILLIAM L. BATT,

President, American Society of Mechanical Engineers

THE growing interest in welding and flame cutting is amply demonstrated by the fact that the space to be occupied by the various exhibitors who will show all of the latest developments will, this year, be far larger than at any previous convention.

In the relatively short time that welding and cutting have been recognized by the regulatory bodies remarkable progress has been made. For example, there are now in use, and all with excellent service records, over 4000 pressure vessels constructed in accordance with the highest requirements of the American Society of Mechanical Engineers Code, and the number of buildings completely or partly fabricated by means of welding and flame machining is rapidly increasing.

The excellent service being obtained with thousands of miles of pipe, much of it operating at high pressures, joined by welding or brazing, should be sufficient to satisfy even the doubtful as to the merits of this method of fabrication.

The executive and engineer will find much of interest in the various technical papers dealing with the fabrication of the newer alloy steels and in viewing demonstrations of the latest developments in welding and cutting and the equipment used.

The architect and heating engineer together with the plumber and pipe fitter will learn why the old threaded joint is rapidly giving way to the more modern welded or brazed joint. And they will see how easily some of the modern joints can be made.

The two sessions on fundamental research, together with the evening sessions given over to the university research work will offer opportunities for the metallurgist and test engineer that should not be missed.

JOHN J. CROWE,
President, American Welding Society

Metal Congress Welcomes

IT is a privilege, indeed, to welcome to the National Metal Congress the members and friends of the various associations that are meeting in Cleveland on Oct. 19-23.

The Metals Divisions of the American Institute of Mining and Metallurgical Engineers—the Iron and Steel Division and the Institute of Metals Division—are, as in past years, holding their fall meetings in conjunction with the National Metal Congress and Exposition. The technical sessions of the Congress and the Exposition's presentation of the outstanding recent scientific and engineering accomplishments in metallurgical fields furnish added acceleration to the steadily increasing activity, efficiency, and accomplishments of the metals industries. The divisions of the American Institute of Mining and Metallurgical Engineers primarily interested in other phases of the mineral industries, in the mining and processing of metallic and non-metallic minerals, of coal and of petroleum, are also keenly interested in advances in the technology and engineering applications of metals and alloys, as many of their problems have profited from such advances in the past and will continue to do so in the future.

JOHN M. LOVEJOY,
President, American Institute of Mining and Metallurgical Engineers

DIRECT ROLLED ALUMINUM

By T. W. LIPPERT
Metallurgical Editor, The Iron Age

MODERN industrialists have long been divided into two schools of thought. One group holds firmly to the belief that periods of depression should be counterbalanced by means of individual retrenchment and concentration of energy in established and reliable activities. In opposition, another group considers the comparative inactivity during depressive periods as prime opportunity for dynamic research leading to the development of better and cheaper manufacturing processes. Thus, full and profitable advantage can be taken of subsequent boom periods.

Crown Cork & Seal Co., Baltimore, definitely belongs in the latter classification, mainly as a reflection of the attitude of C. E. McManus, president.

On three previous occasions, Mr. McManus has initiated new processes as the economic cycle was swinging downward. And, for the fourth time, a most ambitious schedule of development and expansion was started over three years ago, at a time when many other industries were blanketed with gloom. Mr. McManus is somewhat chagrined in the current instance, however, for there has been a slight miscalculation of the time cycle. The depression is over in his opinion, whereas his new developments won't be in production fully for six more months.

Within the six months, the enormous new 19-acre Crown Can Co. plant at Philadelphia will start turning out 3,600,000 beer and sanitary cans daily, with an ultimate potential production of 7,500,000 cans daily. A small portion of the plant will be devoted to steel barrel fabrication, an entirely new line for the Baltimore concern. This one depression - born expansion alone will increase the company's tin plate consumption threefold, from about 1,500,000 base boxes yearly to, perhaps, 4,000,000 base boxes. In addition, several small independent producers in other sections of the country have been quietly bought out, thereby further increasing Crown Cork & Seal

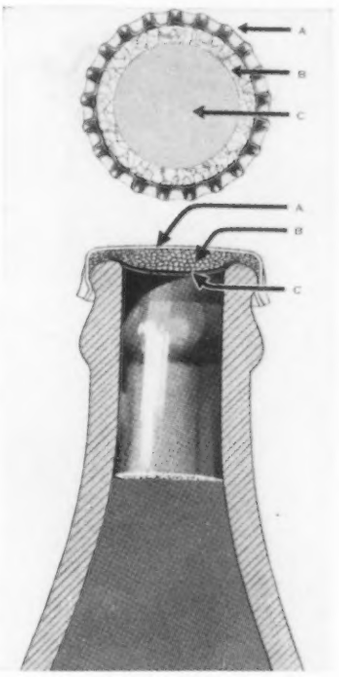
Co.'s tin plate requirements to the neighborhood of 5,000,000 base boxes.

This tremendous expansion in can capacity is predicated solely on Mr. McManus' firm conviction that within several years the country's present can and tin plate capacity will be insufficient to satisfy the demand for canned beer and other canned products now relegated to glass containers. In defense of its belief, the company points to the increasing demand for beer cans, and, in addition, the sharply declining percentage of beer volume going into kegs. When the Eighteenth Amendment was thrown into the discard, 85 per cent of the country's beer went into kegs whereas this ratio has now dropped to 35 per cent. Over the next several years the percentage may drop even further with concomitant gains for both the bottle and can industries. Of the 65 per cent of beer now in containers, cans secured only 13 per cent last year, but Crown Cork & Seal Co. confidently expects canned beer to enjoy constantly increasing favoritism.

This story, however, is not based on the confidence the Baltimore concern has in the future of cans. After all, the can expansion is a natural, albeit very large, growth of a well-established company which has been making some of the country's cans and most of the bottle closures since 1892. The really noteworthy fact is that one of the heaviest buyers of rolled aluminum is now in a position to supply all its own requirements; and one of the steel industry's most desirable patrons soon expects to be about one-half self-sufficient.

Likewise noteworthy is the fact that even now the company is in production on aluminum coated steel, a proprietary product said to be superior to tin plate for many purposes. A new alloy also has been developed and may soon be introduced to the can industry—it will be corrosion resistant, and is said to be cheaper and considerably lighter than tin mill black plate.

But, even a transition from consumer to producer (and, perhaps, to competitor) is not unique in itself—the factor that makes this particular case outstanding is that self-sufficiency has not been attained by installing conventional production equipment but is predicated entirely on the development of and confidence in the revolutionary Hazelett direct-rolling mill. In the past two months over 215,000 lb. of aluminum has been direct-rolled in one operation from the liquid state, and some of this material has already been marketed in consumer products. Furthermore, before the year's end, the company expects to be melting down its own steel scrap, heretofore sold back to steel mills, and direct-rolling it at the rate of five tons hourly. The steel strip so produced will subsequently be reduced to tin plate gage in the five-stand four-high continuous mill pictured in the accompanying insert. Provisions have been made to tin some of this steel if the company so desires, but by far the greatest percentage will be aluminum coated by a recently perfected process. A sizable quantity of this aluminum-coated steel already has been quietly placed on the market in the form of screw caps for whiskey bottles.



The Homely Crown Cork

IT is hardly noticed by the average user; for it is merely something to pry off in order to secure the contents of a bottle. To Crown Cork & Seal Co., however, it is a highly important product which sells for 0.12c. apiece and consumes about 50,000 tons of tin plate and 1,000,000 lb. of aluminum foil yearly. To further cheapen and improve the crown, about $6,000,000 has been invested and two revolutionary manufacturing processes have been perfected. The formed crown shell (A) is fitted with composition cork (B) which is protected from the contents of the bottle by a spot of aluminum (C).

Thus, Crown Cork & Seal Co. becomes the first to successfully produce aluminum in the direct-rolling mill and bids fair to become the first to turn out steel commercially. The company likewise holds the key to successful commercial hot-dipping of aluminum onto steel. Both these processes have tremendous industrial significance, and for this reason their technical aspects will be considered in the following paragraphs.

Worthy of first description is the direct-rolling mill. Crown Cork & Seal Co. and the Aluminum Co. of America are sole licensees to produce aluminum in the Hazelett mill. The latter firm has just completed a large modern mill at New Kensington, Pa., but only has started to overcome the many inherent idiosyncrasies of the mill which Crown Cork & Seal Co. has already mastered through the ingenuity of Mathew Schon, general manager of the metals department, assisted by George Nauss, chief metallurgist.

The direct rolling mill for over a year has successfully produced many tons of brass at the Waterbury, Conn., plant of the Scovill Mfg. Co., and the material so produced has proved exceptionally amenable to deep-drawn consumer products. The only description of this installation appeared in THE IRON AGE, March 21, 1935, and in that article the general operation of direct-rolling mills was considered in detail. Suffice to say, such a mill is essentially two horizontal rolls, one of which is equipped with a flange so that a shallow pool of molten metal can be supported between them. If the rolls are separated by, say, ⅛ in. and are set in rotation, it is not hard to visualize how some metal is constantly frozen on each roll, and, as the rolls rotate, this frozen metal is pressed together and emerges as homogeneous and smooth-surfaced strip. It is a mistake to look on the emerging strip as cast metal strip; for a modern mill like that at Baltimore imparts considerable rolling reduction to the metal after it has been chill cast on the two roll surfaces. In addition, the strip has just recently been improved considerably by drawing it from the mill under an extremely high tension.

Thus, metal produced in the di-

rect-rolling mill undergoes what is essentially a casting-rolling-extrusion cycle.

Aluminum Peculiarities Overcome

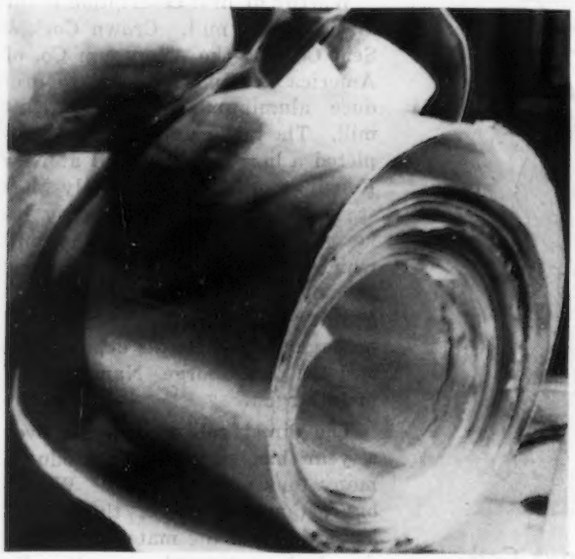
Unfortunately, only a few of the experiences gained by Scovill in the production of brass could be transferred to the direct-rolling mill for aluminum. This resulted from the inherent peculiarities of the metal aluminum, which even in conventional ingot-rolling practice is one of the most exasperating and "ticklish" of metals to handle. Molten aluminum is very sensitive to temperature changes and it oxidizes very rapidly. In addition, it is necessary to coat the steel rolls with aluminum before satisfactory rolling results, and, occasionally, it requires weeks of patient effort to secure a proper aluminum coating on the rolls. But, on the other hand, methods are being developed which cut this time to a few hours. This necessity of properly coating the rolls is common to the direct-rolling mill and conventional hot and cold mills for reducing ingots.

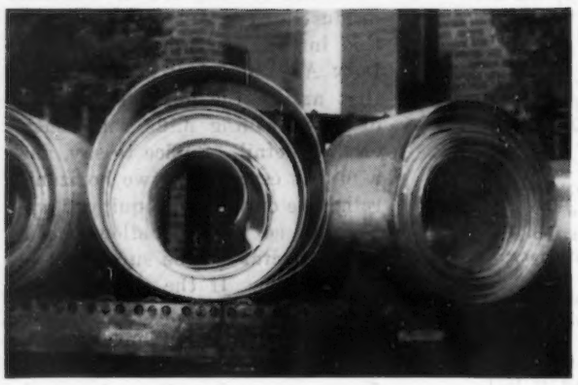
Mr. Schon and his associates devoted months of work to experimenting with various roll materials to which aluminum would not stick. But no material was found which fulfilled this requirement and at the same time was desirable physically and economically. Other months were spent in experimenting with various nozzle designs for properly distributing the metal between the rolls, variations in the water-spray practice for cooling the rolls were studied, and it even became necessary to develop suitable alloys for the metal distributors which would have the ultimate resistance to the corrosive and erosive action of molten aluminum.

All this experimental effort was spread over about one year's time. There can be no doubt but what the final accomplishment justified the labor involved. For consider that the first metal turned out had extreme gage variations, a poor surface, was inclined to tear and seldom ran over several feet without getting ragged or stopping altogether. Now turn to the insert with this article and examine photo (1). There is pictured the mill steadily turning out about the best looking aluminum strip this writer has ever seen. Notice the clean edges and the extreme smoothness of the surface. The metal is being rolled 24-in. wide. The usual edge thickness is 0.120 in., and the center is deliberately crowned slightly to 0.122 in. Gage variations are so small as to be ignored, and the completed coil measures about 500 ft. in length.

This one small mill has potentially a very large production. It takes about 28 min. to roll 1800 lb. of aluminum to the width and gage just mentioned. There is not one pound of scrap loss in the entire run, and the investment and operating cost of producing metal continuously is extremely low when compared with conventional production procedures. Crown Cork & Seal Co. has in the past purchased large quantities of foreign aluminum, and, even when a 4c. per lb. duty is paid, the delivery price to Baltimore is estimated as being considerably under 19c. per lb. Thus it is conceivable that even now aluminum could be direct-rolled from this foreign metal into continuous strip 24 in. wide and 0.120 in. thick and ready for immediate fabrication at a price competitive with domestic aluminum pigs.

This last statement implies that the aluminum in just the condition it comes from the direct-rolling mill is suitable for fabrication. And such is the case. The surface has a pleasing matte finish, and, physically, the direct-rolled metal is equal to or superior in some respects to ordinary aluminum hot-rolled from ingots. As the metal leaves the mill it has a half-hard temper—the tensile strength is about 13,000 to 15,000 lb. per sq. in., as compared with a value of about 7000 lb. per sq. in. for ordinary cast aluminum, and 9,000-10,000 lb. per sq. in. for ordinary full-annealed hot-rolled aluminum. Ductility tests are highly satisfactory, and Brinell hardness determinations (500 kg. load) taken at equal intervals across the width of the 24-in. strip run in the following typical fashion—29, 31, 31, 29, 30, 31, 31, 30, 33, 30, 28, 31, 30, 30, 30,





o o o

TWELVE months of experimental work has ironed out many of the aluminum direct-rolling difficulties. The ragged torn, off-gage aluminum above was the typical product first produced on the mill last November. Below are coils produced today—the strip has a uniform matte surface finish, gage variations are far under one-thousandth, the edge is smooth and scrap loss is nil.

o o o

30, 28, 28, 31, and 31. Thus there is no physical reason to prevent aluminum from leaving the direct-rolling mill and immediately entering a punch press for fabrication into a variety of sheet metal products.

Under the microscope the direct-rolled aluminum naturally does not have the appearance of cast metal. Occasionally it resembles rolled aluminum but just as often it has a bastard structure which has yet not been fully analyzed and which probably originates when some of the interior metal is being rolled in a mushy state.

o o o

THE aluminum direct-rolling mill was suddenly stopped and a slug of metal froze. When this slug was sectioned and etched, as shown here, it became obvious that the mill is constantly reducing what is essentially a solid, hot, constantly reforming tapered ingot. The roll positions are sketched in; also shown are the temperature of the liquid metal entering the rolls and the temperature of the strip just as it leaves.

o o o

Will Produce Foil

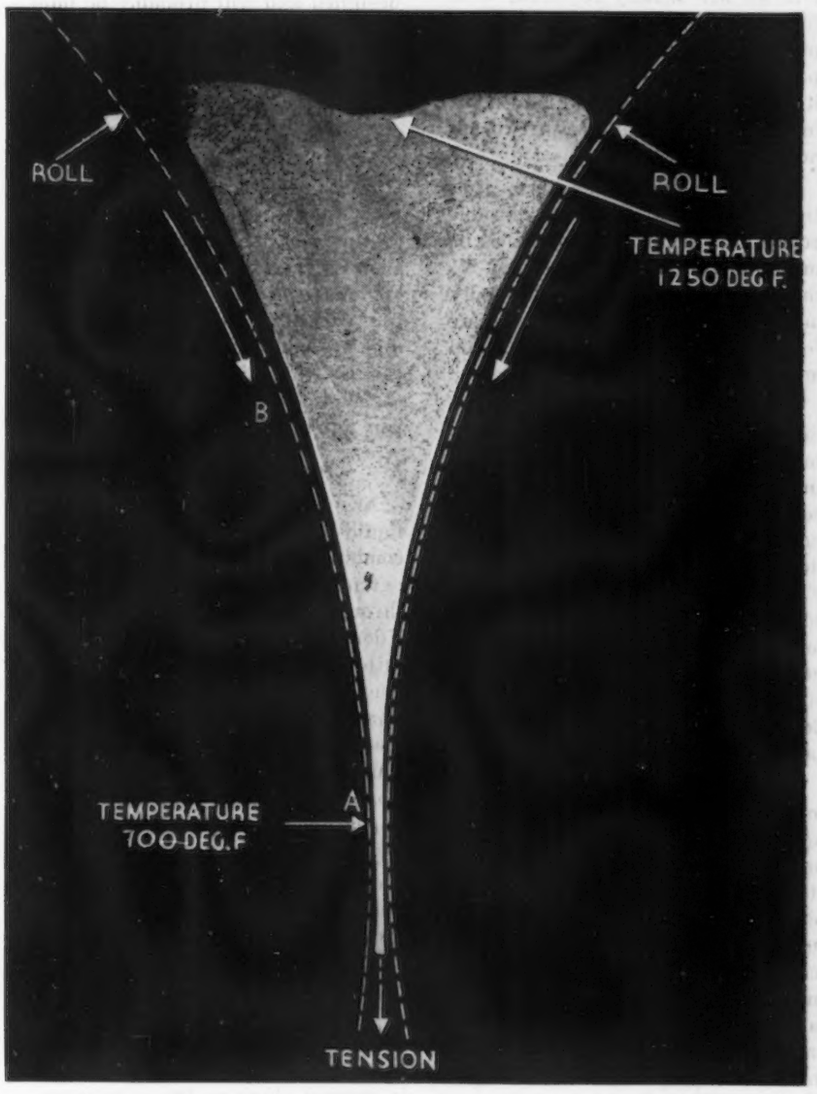
But Crown Cork & Seal Co. has little use for the size and gage of aluminum as it comes from the mill. This is merely the first step leading to ultimate reduction to aluminum foil for use as "spots" in the crown cork. The application of this "spot" is shown in the drawing on page 27, and its function is to prevent liquids in bottles from absorbing the natural taste of the cork.

The "spots" are quite small and very thin, but, nonetheless, a surprisingly large amount of aluminum is consumed for this purpose —over 1,000,000 lb. yearly is bought by the Baltimore concern. Foil of this type is quite costly, being priced in the neighborhood of 48c. per lb. But Crown Cork & Seal Co. is confident that foil can be reduced from direct-rolled metal in its own plant at a price considerably lower.

To accomplish this end considerable equipment has already been installed. The direct-rolled aluminum strip will be made dead soft in the vertical annealer pictured in the insert, after which it will be reduced in the continuous cold mill from 0.120 in. to 0.040 in. Thence it will be again annealed, and then passed through a large foil mill now being installed. The strip leaves the foil mill 0.002 in. thick, after which it will be given a final anneal, coated with thermo-plastic cement and then punched out into "spots."

It should be noted that direct-rolled aluminum is made into foil with only three anneals and a minimum of rolling. This follows from the fact that the metal is very malleable and shows marked ability to withstand heavy reductions. One foreign foil plant has reduced several coils and has reported that the final product was definitely superior to foil previously rolled down from ingots.

This cycle from direct-rolled aluminum to foil is particularly favorable when compared with the



conventional method of producing aluminum foil. That is, aluminum is usually cast in 200 to 300 lb. slabs about 4 in. thick. Frequently the entire surface is scalped, after which the ingots are hot rolled eight or ten times down to 0.5 in., usually with one intermediate reheating. These breakdowns then take 12 to 14 passes in a cold roughing mill and emerge about 0.040 in. thick. Two intermediate anneals are usually required. Cold finishing units then reduce the metal from 0.040 to 0.010, with four passes and one anneal, after which it is reduced in a foil mill to 0.002 in. in five passes and with two anneals.

It is apparent, therefore, that this procedure entails considerable scrap loss, requires more time and more individual operations, and, for these reasons, must be decidedly more expensive than for similar foil produced from direct-rolled metal.

So successfully is Crown Cork & Seal Co. making direct-rolled aluminum for subsequent reduction into foil that it will be completely self-sufficient, and, quite likely, will have excess production for sale to licensees making the "spot" crown. Furthermore, it is not unlikely that coils will be sent to European mills making foil and selling abroad, and negotiations are also under way for supplying an American unit which does a sizable independent business in mounted and embossed foil.

Still further, the company's aluminum position is now so encouraging that definite arrangements have been made to branch out in still another direction. A collapsible tube machine has already been installed and others will be bought as market demand grows. In making products from direct-rolled aluminum, a certain amount of scrap ensues. This scrap will be stamped into small plugs and drawn into toothpaste tubes, etc. Preliminary experiments have shown the metal admirably suited to this operation.

At the present time Crown Cork & Seal Co. uses one electric resistance furnace for melting aluminum. It takes several hours to melt down a 1800-lb. batch of cold pigs and only 28 min. to pour the charge. Obviously, therefore, the operation is necessarily intermittent. Inasmuch as the Hazelett mill operates to best advantage in constant production, a continuous melting unit would be economically desirable. Such a furnace is now being designed, and, when placed in operation during the turn of the year, it will permit continuous rolling of aluminum delayed only by occasional roll changes.

The experimental work on the present direct-rolling mill has disclosed various refinements which would facilitate the operation. For this reason, a second and larger aluminum mill is even now being designed and will probably be built during the next year. The new unit will probably roll strip 30-in. wide and will have a secondary set of reduction rolls. That is, as the strip leaves the direct-rolling rolls, it will immediately pass while hot through another set of reducing rolls and will emerge 0.06 in. thick. In this way, it will not be necessary to pass the strip through the continuous cold mill. Also, through the use of a neutral atmosphere and a reduction in the amount of cooling water, it is anticipated that the metal will have almost a mirror finish.

Action During Rolling

As previously mentioned, the liquid-solid aluminum undergoes a combination casting, rolling and extruding action as it passes through the direct rolling mill. Accidentally, better insight was given into this particular phase of the operation when once the mill was unavoidably shut down and liquid metal froze between the rolls. This plug of metal was removed, sectioned and etched and showed the appearance reproduced on page 29.

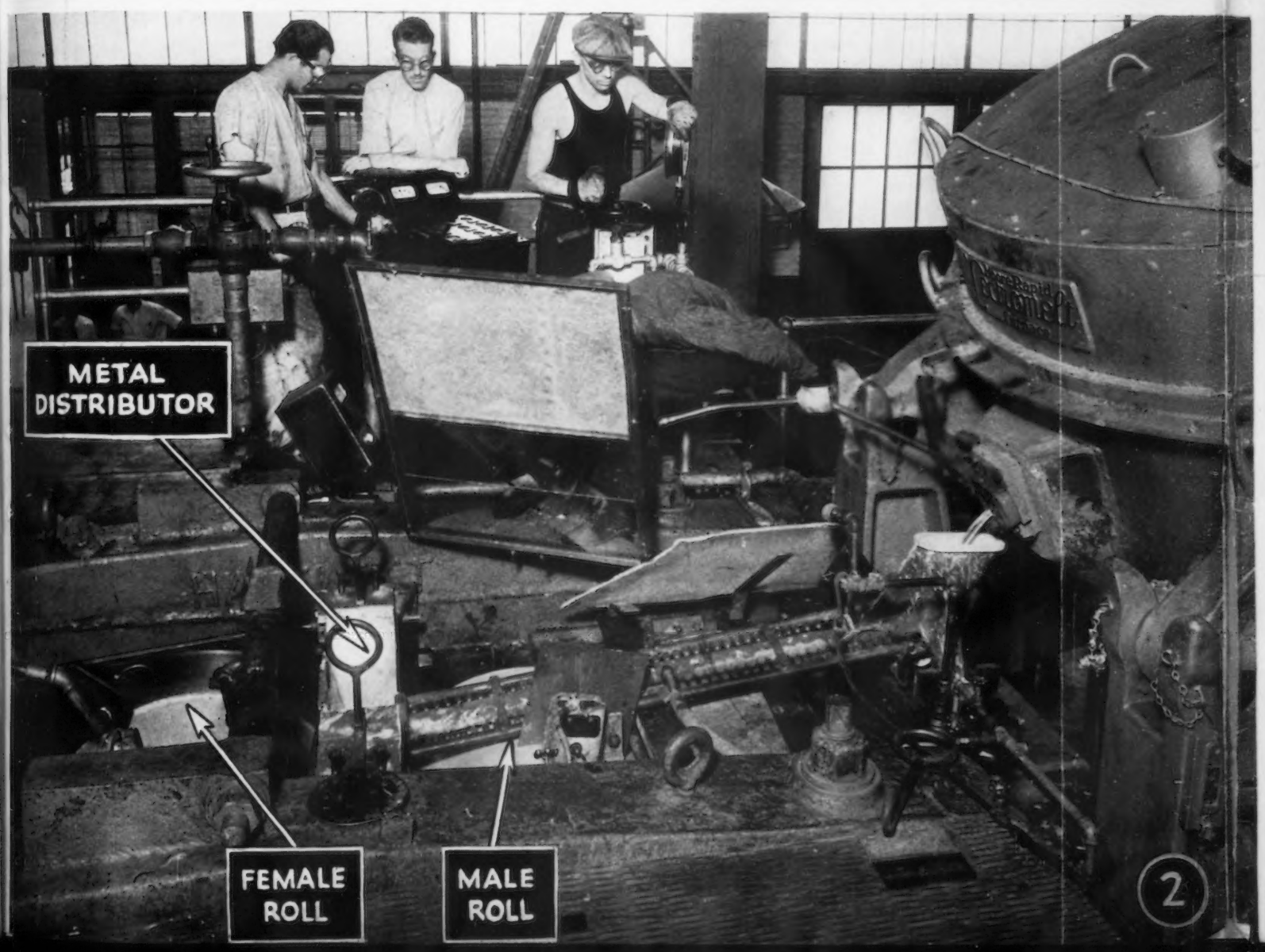
The metal which solidified from the molten state shows up as being quite porous. That metal which froze onto the rolls is more dense (as shown by the thin line of solid metal from A to B on each roll) and is the start of an operation which is completed further down between the rolls. This cast metal is carried along as the rolls rotate and encloses a certain amount of liquid or semi-solid metal which rapidly solidifies as all the metal receives its maximum hot reduction right at the nib of the rolls. This reducing action is accentuated by the use of a tension up to 25,000 lb. (across the total 24-in. width). The actual rolling pressure during this operation varies between 1,600,000 and 1,800,000 lb., as determined by a Messinger pressure box, and it only requires between 70 and 85 hp. to turn the rolls.

By means of some clever control work by Clark Controller Co. this power is available immediately as the mill starts. That is, as a run of metal is begun, the rolls are kept stationary until a pool of metal builds up between them—then the motor is started and the rolls turn immediately at practically full speed and full power. And as the pool of metal grows higher, the control steps up the roll speed slightly. By this arrangement, a metal strip at the beginning of a pour starts out with a clean edge and at full gage.

The photograph of the slug would indicate that the pool of liquid metal between the rolls is carried about 5½ in. deep. However a more shallow pool is generally used—about 2 to 3½ in. above the nib of the rolls. For the 3½-in. depth, the liquid metal pool measures about 2 in. across from roll surface to roll surface. A consideration of the non-porous section shown in the slug photograph would indicate that a considerable portion of the metal receives a sizable amount of hot reduction for a travel distance of about 1 in. or more between the rolls. It is this reduction which gives the metal a one-half hard temper as it emerges.

The temperature of the aluminum as it enters the pool of metal between the rolls is about 1250 deg. F. and just as the metal leaves the rolls its temperature is close to 700 deg. F. Immediately thereafter water is sprayed onto the surface and a few feet further on the metal is cold to the touch.

With all the factors previously mentioned in mind, it is apparent that there is no mystery about the operation of a continuous-rolling mill. The rolls are actually reducing what is essentially a constantly reforming, solid, tapered ingot of hot metal. In this respect it is similar to the ordinary blooming mill —for if a slug of liquid metal in the direct-rolling mill were to be permitted to solidify, it could still be rolled out into a sheet if enough power were to be applied to the rolls and the housings stayed in one piece. However, by rotating the rolls constantly and only permitting a small amount of metal to solidify at any one instant, the total metal reduction is considerably lessened, the power requirements are much lower, impurities constantly float on top of the pool of metal, and a strip of indefinite



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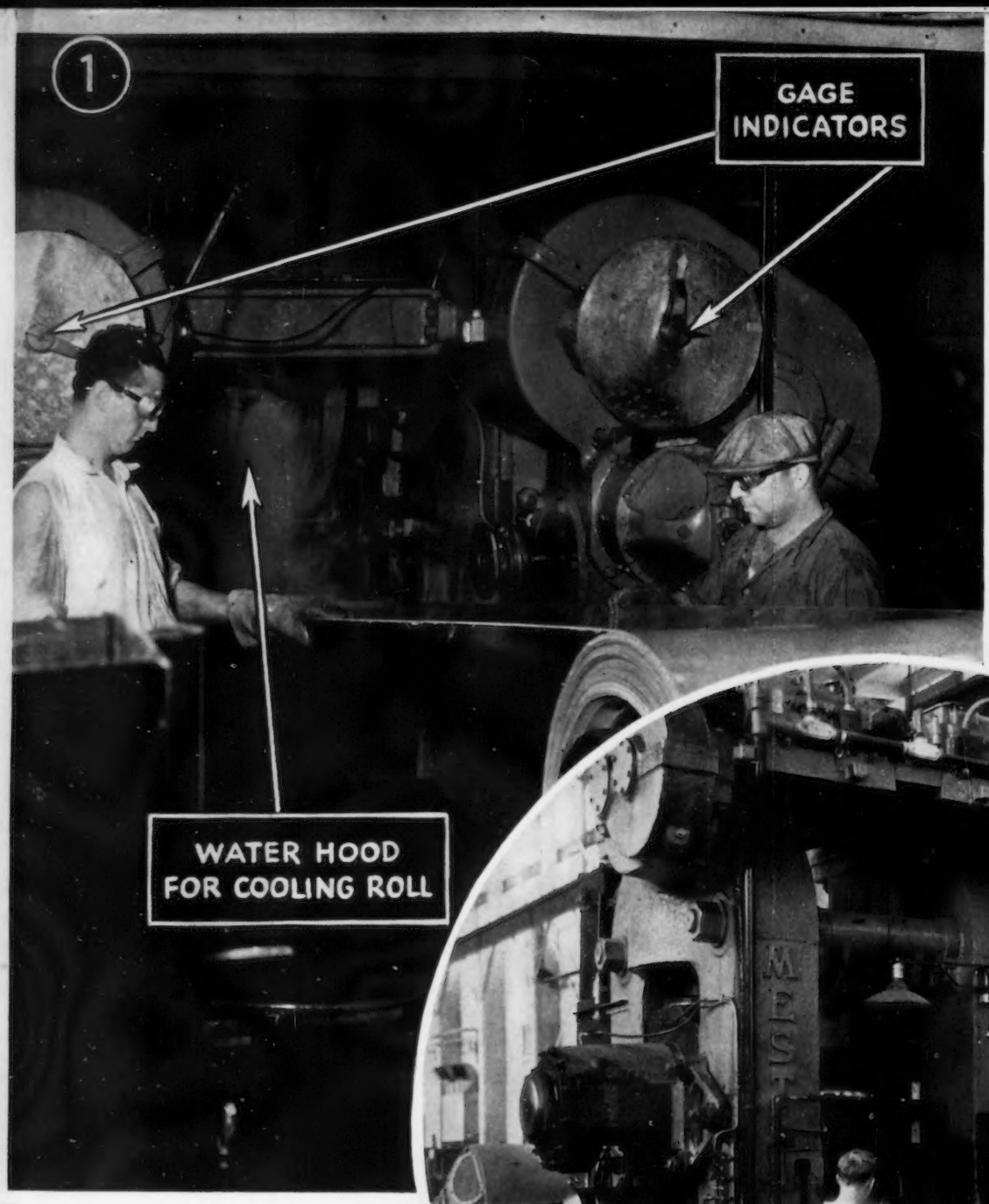
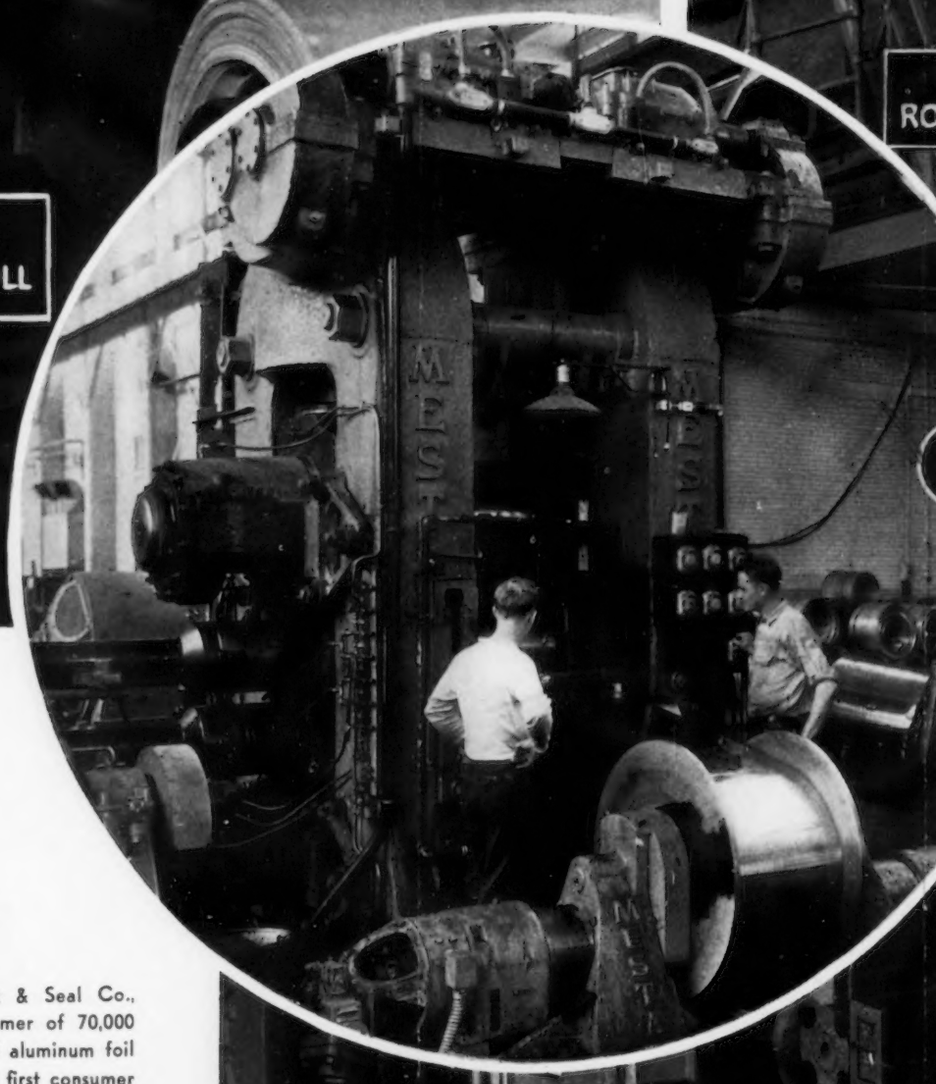
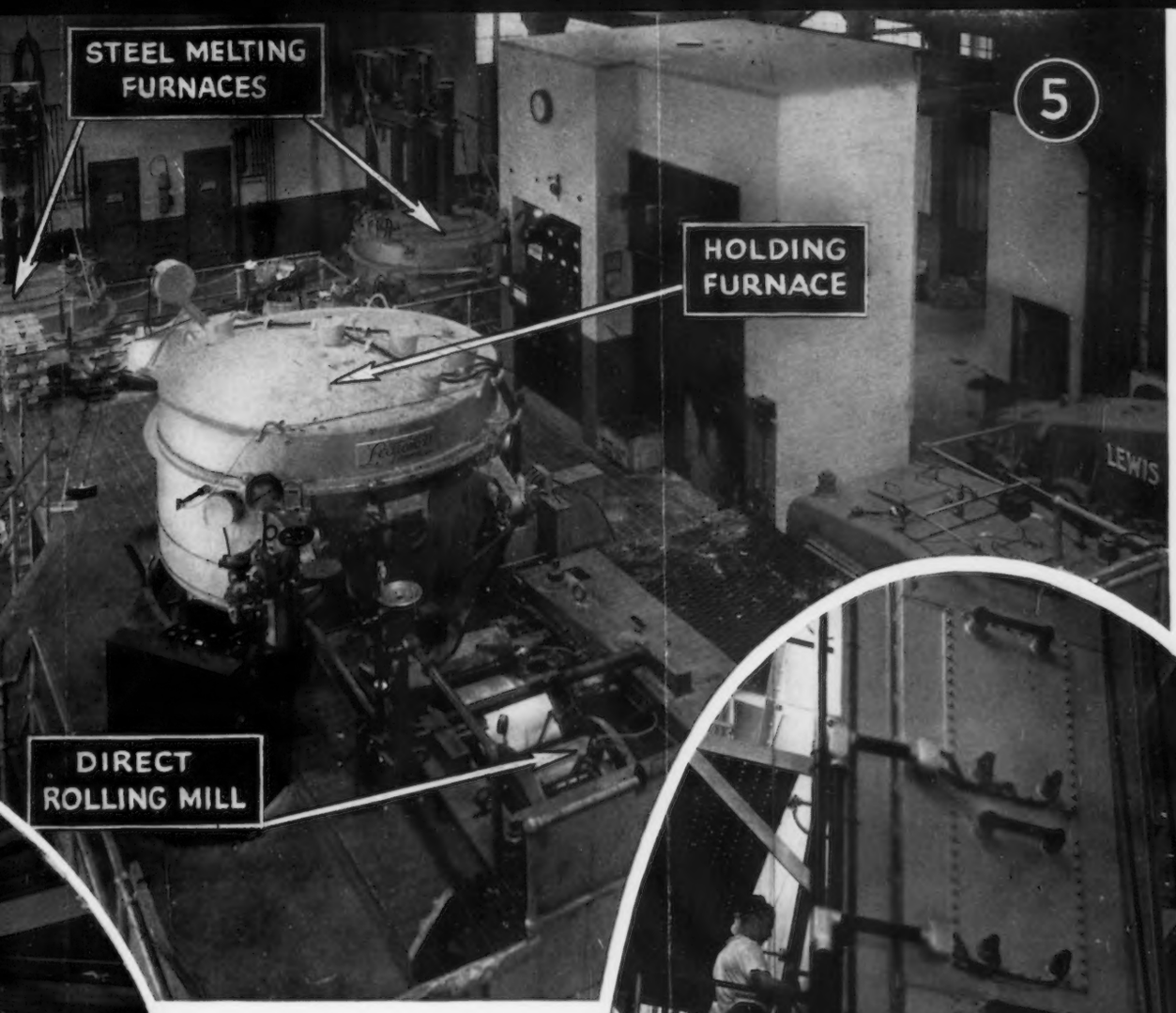


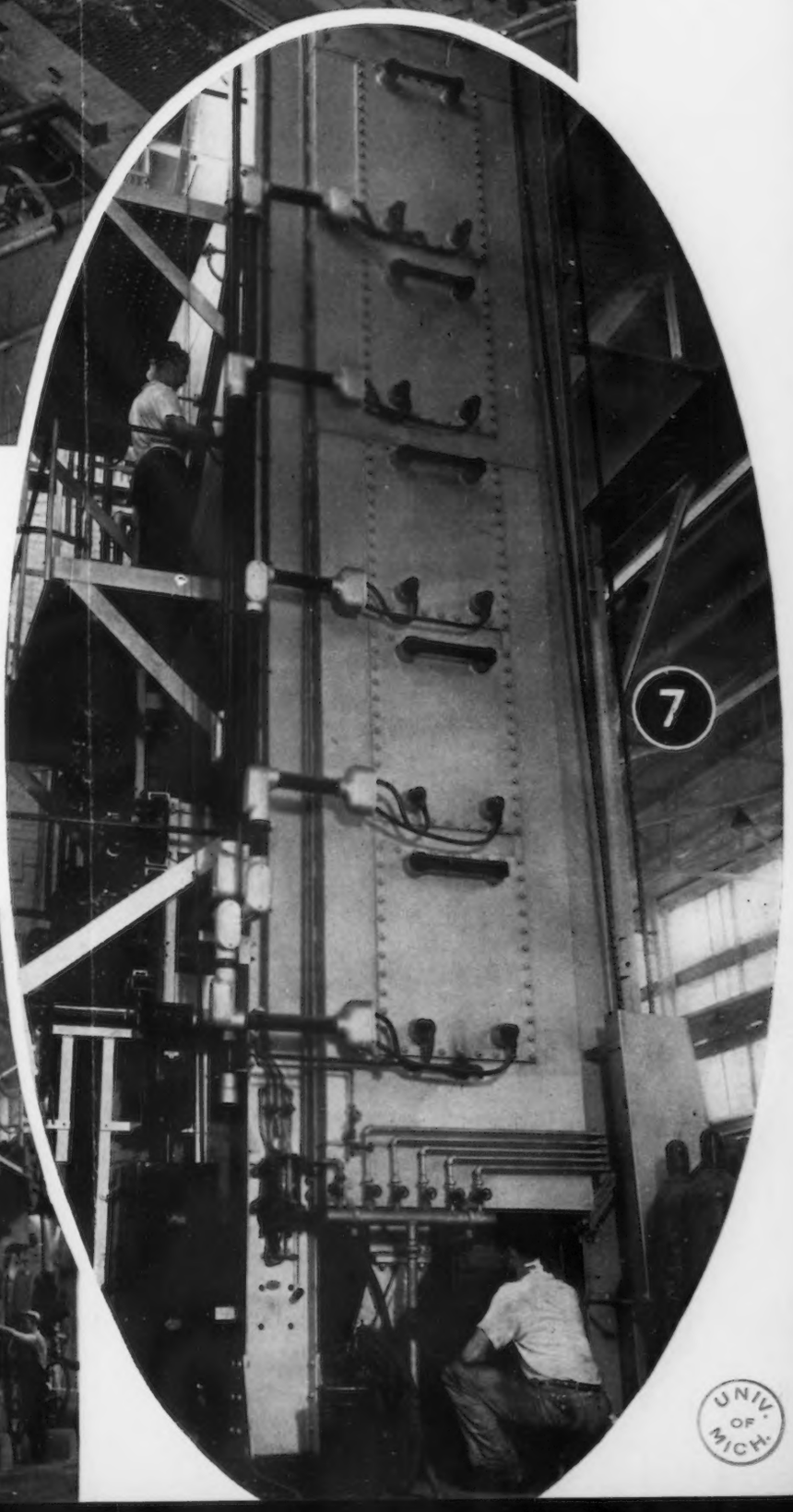


Metamorphosis of a Consumer

AS an example, consider Crown Cork & Seal Co., Baltimore, which is normally a consumer of 70,000 tons of tin plate and over 1,000,000 lb. of aluminum foil and bands yearly. This company is not the first consumer to turn producer, but it has won special mention through the perfection of the revolutionary direct-rolling mill to attain self-sufficiency in aluminum, and, probably, partial self-sufficiency in steel. In these first pictures showing the scope of operations at Baltimore, note the perfect surface and clean edge on the continuous aluminum strip coming from the direct-rolling mill (1) 24 in. wide, 1/8 in. thick and at a speed of 15 ft. per min. Aluminum is leaving the furnace and entering between the rolls in (2); (3) is a side view of the Hazelett mill; and (4) shows direct-rolled aluminum being reduced to foil in a 4-high cold-rolling mill.



THE company's own steel scrap is melted in two arc furnaces, then brought to correct temperature in the holding furnace (5), and subsequently poured into the direct-rolling mill. The steel emerges 40 ft. per min. as continuous strip 24 in. wide and 0.065 in. thick. After sandblasting, the strip is reduced to tin plate gage in the continuous mill (6) and then is softened in the vertical electric annealer (7).



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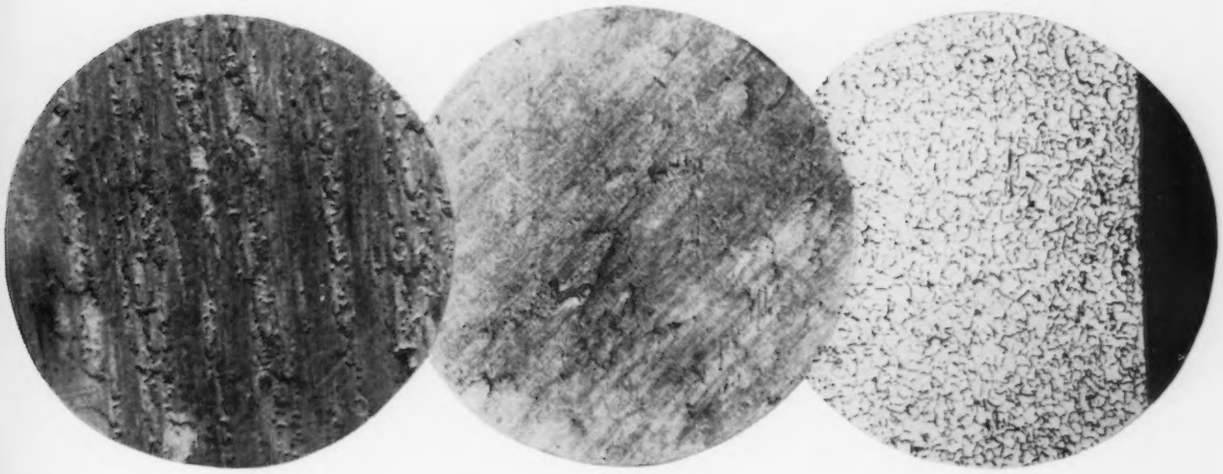
length, from one foot to one mile or more, can be secured.

Although much of the activity at Baltimore has been devoted to aluminum, enough experimental work has been done with steel to make the metals laboratory confident of satisfactory commercial operation within the next six months. During this period, a full range of experiments will be conducted to develop desirable mill characteristics and operating technique. With this information at hand, a new 30-in. direct-rolling mill for steel will immediately be built. It has already been determined that direct-rolling with low-carbon steel is much more easily accomplished than with high-carbon analyses. An important requirement, also, will be molten steel which is quite clean and comparatively free of gas. When these conditions are met, less trouble is anticipated with steel than was the case for aluminum. At the outset there will be no necessity of coating the rolls and the sticking problem will be far less severe.



THE oxide coated surface (left), of steel just as it leaves the direct-rolling mill. The middle surface micrograph at 14 diameters with oblique illumination is of this same surface after pickling. The micrograph at 100 diameters on the right shows the excellent fine grain near the surface of "as-direct-rolled" steel.

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Direct-Rolled Steel

Crown Cork & Seal Co.'s canning machinery division accumulates considerable scrap each month and there is also a sizable amount of waste involved during the stamping of crown corks and packers' cans. All this scrap, which has previously been sold in the open market, will care for a sizable proportion of the direct-rolling mill requirements. There is about 16,000 tons of the waste material now accumulated at Baltimore, and it is expected that most of it will have been direct-rolled into strip during the next half year. The scrap, together with suitable refining agents, will be passed through two top-charge Lectromelt arc furnaces. On batch cold melt practice, these two furnaces are capable when operating steadily and under favorable conditions of making a six-ton heat every 1½ hr. One view in the accompanying insert shows the relative location of these two batch melting furnaces. Between the furnaces and the Hazelett mill, a holding furnace is located (the holding furnace actually shown in the insert is a resistance type for aluminum—it will be supplanted by an arc furnace for steel). The holding furnace will operate on duplexing practice, i.e., it will receive its charge in molten form from the two melting units. The holding furnace can be operated with from 4½ to a 9-ton bath or even larger, and its function is to bring the steel to the exact temperature required by the direct-rolling mill and to feed it into the distributor at the proper rate. When the operation of the two arc melting furnaces are staggered and used to build up a supply of metal in the holding furnace, it is evident that the direct-rolling mill can turn out strip at a constant and rapid pace.

After the continuous strip leaves the direct-rolling mill, it will pass through a Wheelabrator unit for removal of the film of scale adhering to the surface. Thence, it will pass through the continuous cold mill and be reduced to tin plate gage, after which it will be softened in the vertical electric annealer and finally given a temper pass in the single-stand four-high mill. All this equipment is shown in the accompanying insert.

In rolling steel in the direct-rolling mill, the speed of production is, oddly enough, considerably higher than for aluminum—about 40 ft. per min. for steel as compared with 16 to 18 ft. per min. for aluminum. For steel, the temperature involved is quite a bit higher than for aluminum—3000 deg. F., as against 1250 deg. F. for aluminum—but the high temperature in itself and its supposed attack on the roll surfaces is not as serious a problem as is generally assumed. Furthermore, the actual heat to be removed from a pound of liquid steel by the rolls is very little more than the heat to be removed from a pound of liquid aluminum. For the specific heat and the heat of fusion for aluminum is much higher than for steel.

The specific problems to be more completely studied in producing steel involve the correct way to feed the metal, the development of suitable spout refractories, and the determination of suitable rolling pressures and tensions. At Crown Cork & Seal Co. the steel as it leaves the direct-rolling milling will pass immediately through a set of pinch rolls which will feed the strip into a three-high mill for a heavy reduction while it is still hot. A

(CONCLUDED ON PAGE 46)

ELECTRIC HEAT TREATING of WIRE

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By O. C. TRAUTMAN*

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THIS new process consists of continuously heating wire electrically by direct resistance and subsequently quenching on a rising temperature in an alloy having a low melting point. The controlled heating rate and quenching speed result in a product possessing higher physical properties than could be obtained with the conventional methods in use today. In this first description of the process, it is pointed out that there is no decarburization of the wire surface, the equipment is very flexible, easy to operate and has a high thermal efficiency and the heating and quenching cycles can be controlled accurately.

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ONE of the most outstanding developments in metallurgy during the past year has been the introduction of a new process for the heat treatment of spring wire by the electric resistance method at the plant of the Cleveland Wire Spring Co., Cleveland.

The new process and apparatus was developed by the writer, and consists of heating the wire by means of passing an electric current through it, and then cooling the wire through definite temperature ranges. Both the rate of heating and cooling can be controlled with an accuracy and facility difficult to equal with other methods.

The new electric wire heat-treating apparatus has a connected load of 96 kw. and is capable of running six strands of wire simultaneously with a maximum capacity of 500 lb. of wire heat treated each hour. The wire to be heat treated is fed from reels through tension rolls and through individually controlled electrical contact members, where low-voltage current is applied to heat the wire. The temperature increases until the desired quenching point is reached just as the wire enters a quenching bath consisting of an alloy which has a low melting point.

The temperature of the wire is controlled automatically by means of a photo-electric cell unit, which has an optical system so designed that the image of the heated wire is projected to cover the cathode of the photo-electric cell. This unit operates in conjunction with a voltage regulator which holds the temperature of the wire within 5 degrees plus or minus of the desired quenching temperature.

The wire is then further cooled in oil before entering an electrically heated lead tempering bath which is automatically maintained at a temperature of about 800 deg. F. The electric lead tempering bath has a connected load of 20 kw. and is heated with General Electric Calrod heating units.

After passing through the tempering bath, the wire is again

*Cleveland Electric Illuminating Co., Cleveland.

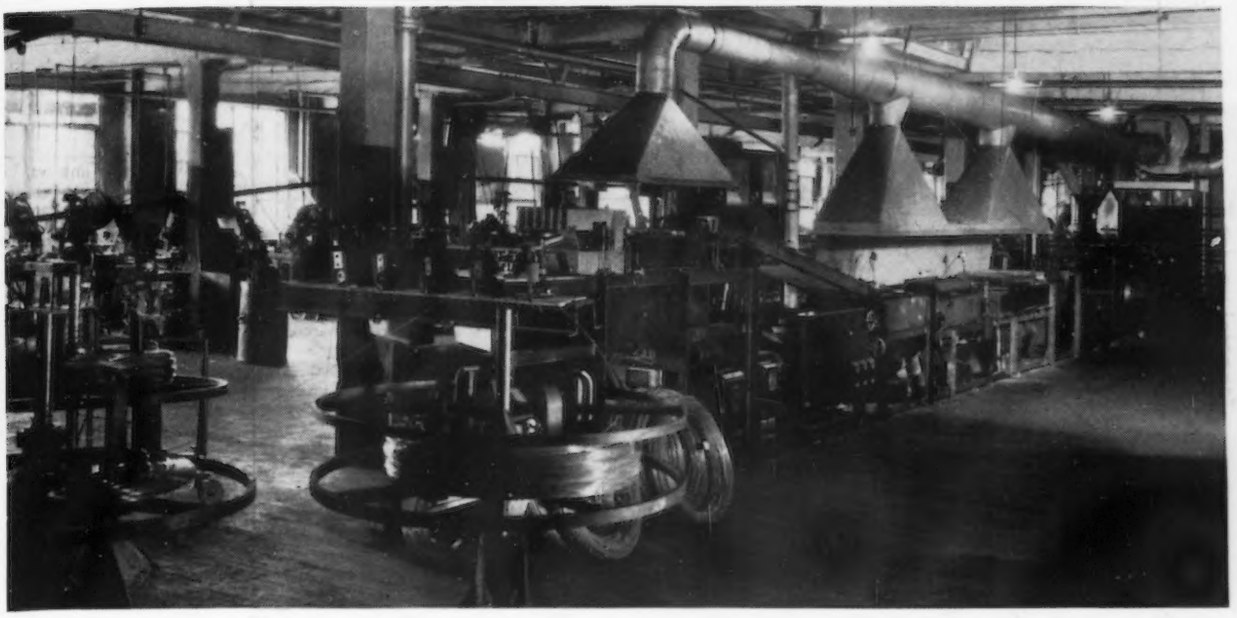

FIG. 1.—Complete unit for the continuous heat treatment of spring wire by the electrical resistance method. Wire fed from reels through tension rolls is heated electrically, quenched in a molten alloy having a low melting point, tempered in an electrically heated lead pot, coated in a liquid bath containing a rust inhibitor, and coiled on take-up reels, these reels being shown at the extreme right.

cooled in a liquid bath which also coats the surface with a rust inhibitor, after which the material passes on to the take-up reels. These reels, which were built by the Broden Construction Co., Cleveland, are of the standard eight-block type and are driven by means of a constant speed motor through a variable speed transmission.

The variable speed transmission is equipped with an electric tachometer, which enables the operator at any time to determine the wire speed in feet per minute. All these steps in the operation are depicted in the two photos in Figs. 1 and 2, which show the Cleveland installation in operation.

Apparatus Is Flexible

The apparatus is extremely flexible and if it is desired to use the machine for lead patenting wire, it is only necessary to raise the temperature of the wire and the quenching medium to the point required for patenting.

In this new electrical heating process high temperature lead pots and furnace equipment are eliminated, together with their high maintenance costs.

Likewise, when annealing wire made of stainless steel and other austenitic steels which require temperatures around 2100 deg. F., no difficulties are encountered in reaching such temperature, as would be the case in furnaces where continuous high temperatures are necessarily dependent on the life of the refractories and materials which enter into their construction.

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According to many wire makers, the present methods of heat treating wire in continuous operation have been inadequate to give the control necessary to consistently obtain the highest physical properties desired. The usual method of heat treating carbon steel wire is to heat the wire to approximately 1550 deg. F., or higher, by passing it through a furnace or a lead pot. Subsequently the wire is quenched in oil, after which it is reheated to approximately 800 deg. F. for tempering in another lead pot.

In this usual process, the heat is transferred to the wire from the outside inward, and, before the interior has attained a temperature desired for quenching, the outside will have attained such a temperature, or even higher, for an appreciable period of time. This results in an undesirable grain growth. Under such heating conditions it is not possible to quench the wire at the instant it has attained the desired degree of heat throughout its cross-section, inasmuch as the temperature of the wire will have dropped before entering the oil quench on account of the space separating the oil quench from the furnace.

In practice under such methods, expediency of heating demands the use of a heating medium operating at a higher temperature than that actually required to heat the wire for quenching. Therefore the exterior of the wire is hotter than the interior at the moment the application of heat ceases. Moreover, as the wire is transferred from the heating furnace to the quenching bath it loses heat from the outer surface. Therefore, the heating is not uniform throughout the cross-section at the instant of quenching.

With this new process of heating by passing a current of electricity through the wire, an even rate of heating is secured throughout its cross-section. This permits a heating rate of from three to four times faster than that which could be obtained by former methods of furnace heating.

The heating cycle is illustrated graphically in Fig. 3, which shows a heating rate of 115 F. deg. per sec. on No. 11 gage, 0.60 to 0.70 carbon, 0.90 manganese wire. This rate may be increased to 400 F. deg. per sec., or decreased as desired. Therefore, there is no ap-

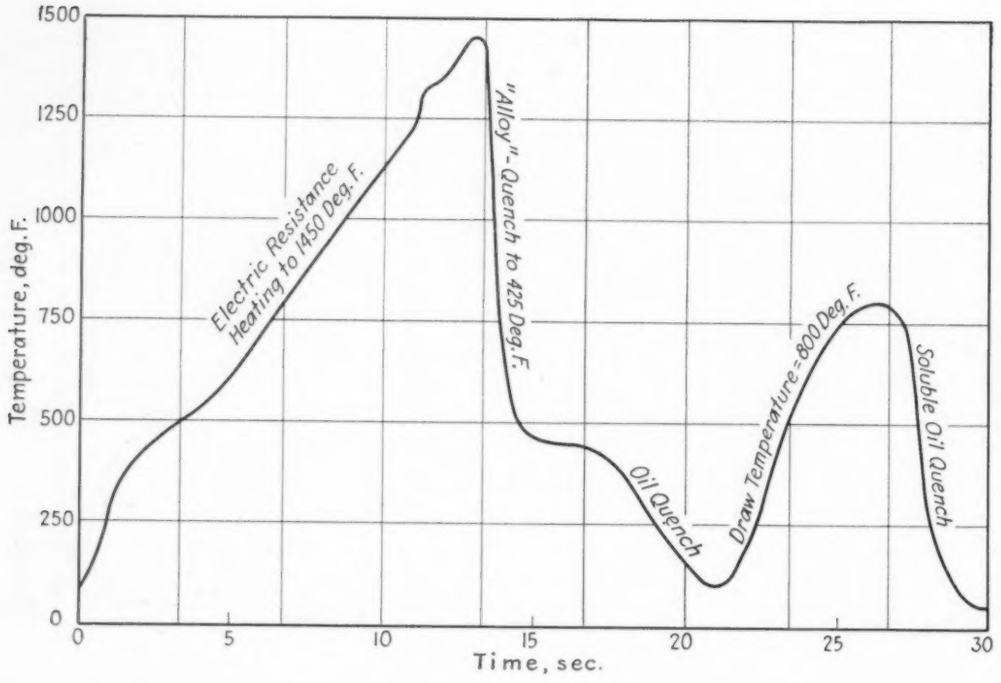

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FIG. 3.—Time vs. temperature for No. 11 gage, 0.120-in. diameter, 0.60 carbon, 0.90 manganese spring wire heated by direct electrical resistance to 1450 deg. F. and quenched on a rising temperature in an "alloy" held at 425 deg. F.

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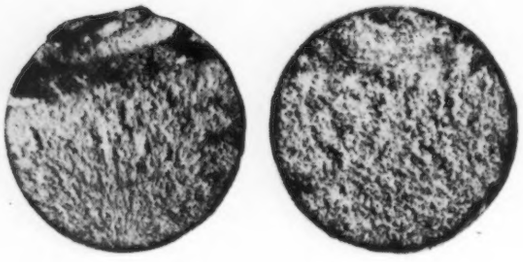

FIG. 4.—Notice the fine grain in the cross-section of wire on the left which has been electrically heated and "alloy" quenched at 1650 deg. F. The coarser grained specimen on the right has been oil quenched from 1550 deg. F. in the conventional manner. Both views are at eight diameters.

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preciable grain growth even when overheating the wire several hundred degrees beyond the temperature necessary for quenching.

Fig. 4 illustrates a No. 13 gage, 0.60 to 0.70 carbon spring wire magnified eight times, showing the fine grain of the wire which was heated by the electrical resistance method to 1650 deg. F. and quenched in an alloy at 425 deg. F., as compared with the same wire

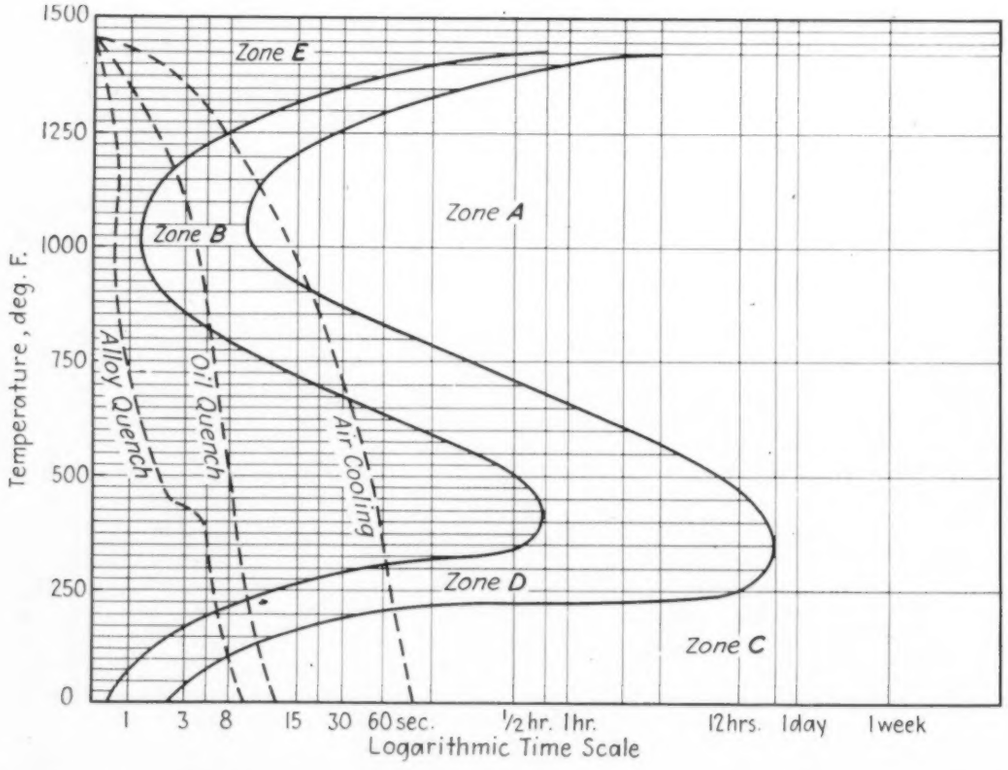

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FIG. 5.—Time vs. temperature curves showing standard S curve for No. 11 gage, 0.60 carbon, 0.90 manganese spring wire. These graphs compare the speed of "alloy" quench with oil quenching and air cooling.

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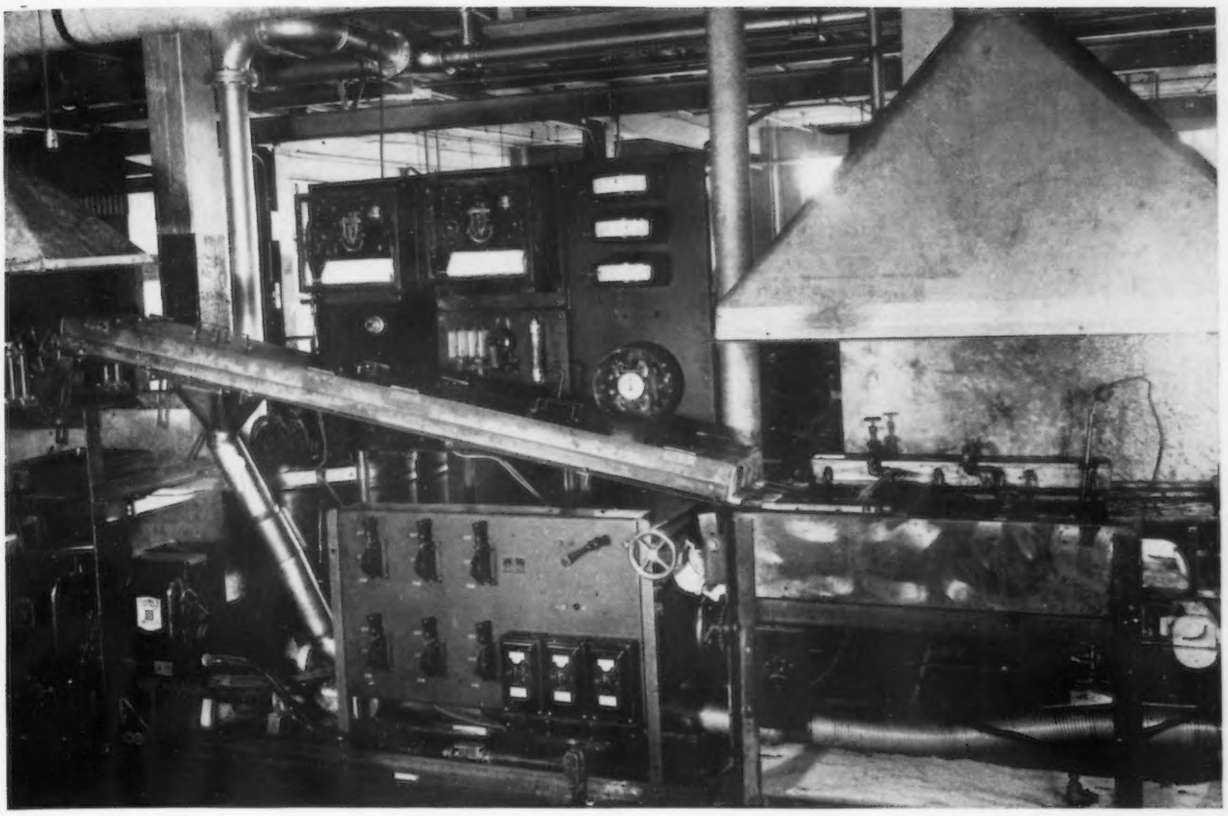

FIG. 2.—Wire from the tension reels passes through the inclined housing into the hot alloy quenching pot at the right. The wire is quenched on a rising temperature in the alloy, which has a low melting point.

heated to 1550 deg. F. in a furnace and quenched in oil.

The heating rate of the wire is proportional to the current flow, and the temperature of the wire as it enters the alloy quenching bath using any specific current flow will be determined by the speed at which the wire advances and the distance between the advanced electrodes and the quenching bath.

In heating wire by this method the temperature of the interior of the wire is raised as rapidly as the temperature of the outside surface, and by controlling the current flow to the wire and the speed at which the wire advances, the wire will enter the quenching bath on a rising temperature and at exactly the temperature desired.

In heat treating carbon steel spring wire by this new method, the wire is quenched at slightly above its upper critical point, or at about 1450 deg. F.

Electrical Heat Balance

One of the serious problems involved in the heat treatment of spring wire by other methods was due to the non-uniformity of the product obtained. This resulted from the fact that in the manufacture of spring wire, there exist occasional flaws such as non-metallic inclusions and variations in the alloying elements which, after heat treatment, produce a hardened wire which is not uniform.

In the new process, despite such variations, uniform hardening is secured, because any increase in electrical resistance encountered at points having such flaws or inclusions will increase the temperature at that point sufficiently to permit satisfactory hardening.

Likewise, equalization of the quenching temperature is secured even though there may be variations in the size of the wire or a variation in the alloying elements. This results from the electrical balance existing between the parallel advancing cross-sections of the wires and the inherent electrical characteristics of the apparatus.

Different sizes of wire can be run in parallel. For instance, in a machine capable of heat treating six strands of No. 11 gage wire, the wire speed being 80 ft. per min,. a No. 13 and No. 14 gage wire could be substituted replacing the two No. 11 gage wires. All of the wires would attain the same temperature at the point of quenching, due to the electrical balance existing between the conducting cross-sections, which varies with the square of the diameter, and the balance of the radiating surfaces, which vary with the first power of the diameter, so that the net heating effect of the current per foot of advancing wire is the same even though there is some variation in the sizes of wire being heat treated.

Referring to Fig. 5, which is drawn to a logarithmic time scale, Zone E represents austenitic steel. When steel is cooled in air as shown in curve marked "air cooling," the cooling curve passes from Zone E into Zone B where the austenite begins to break down and carbides begin to form, transformation being completed when the curve has passed into Zone A and a pearlitic structure is formed. Upon faster cooling, such as oil quenching as shown in curve

marked "oil quenching," the curve does not pass into Zone A, but results in an incomplete transformation to carbide and ferrite, and upon still further cooling the remaining austenite of the steel becomes martensite as the curve passes into Zones D and C. Upon still faster cooling, such as in an alloy quench, the latter being shown as the curve marked "alloy quench," the quenching speed is faster than the critical quenching speed of the steel, consequently the curve does not pass either through Zone A or B, and upon further cooling 100 per cent martensite is obtained.

Fig. 6, which is drawn to a straight time scale, shows the quenching speed of No. 11 gage, 0.120 in. diameter, 0.60 to 0.70 carbon, 0.90 manganese wire, in oil and "alloy" quenches, and, also, the critical quenching speed and the total quenching time. This curve shows the object of the alloy quench, which is to delay the quenching action at some predetermined temperature, after which there is further slow cooling from this point to eliminate any cracking or quenching strains set up by the rapid formation of martensite.

After the wire leaves the alloy quenching bath it passes into an oil quench where the temperature of the wire is reduced to below the temperature of the alloy quench, as shown in Fig. 3. With this type of quench a steel wire having a maximum Rockwell hardness of 64 to 66C is obtained which has a very fine grain and an impact strength of from eight to ten times that obtainable by oil quenching.

In subsequent tempering for spring purposes, the hardness is reduced to 45 to 47 Rockwell C by reheating to approximately 800 deg. F. One photomicrograph shown in Fig. 7 illustrates at 2000 diameters a section of No. 11 gage wire having a hardness of 45 to 47 Rockwell C.

The photomicrograph on the right in Fig. 7 shows a section of No. 11 gage wire at 2000 diameters having a Rockwell hardness of 64 to 66C.

Table I compares the excellent physical properties obtained on No. 13 gage wire heat treated by the new electrical-resistance process, as compared with other methods. A bundle of No. 13 gage 0.091 in. diameter regular spring wire with the analysis: carbon, 0.63; manganese, 0.101; phosphorus, 0.017; sulphur, 0.022, and silicon, 0.19 was taken from stock and one-half was tempered by the conventional method of heating in a furnace to 1500 deg. F., quenching in oil and then drawing in lead at about 800 deg. F.

The average physical values of the wire after heat treatment by the above method are designated as (1) in Table I and in Fig. 8.

The other half of the bundle was heat treated by the electrical direct-resistance method, "alloy" quenched and then drawn in lead at about 800 deg. F. The average physical values of wire heat treated in this manner are designated as (2) in Table I and in Fig. 8.

The improvement in twist, reduction of area, and the higher elastic limit, as shown in Table I and Fig. 8, all indicate a greater toughness in the electrically treated wire as compared with the

AT RIGHT

FIG. 6. — Comparing the quenching speed for "alloy" quench with that for oil quenching. Time vs. temperature for No. 11 gage, 0.60 carbon, 0.90 manganese spring wire.

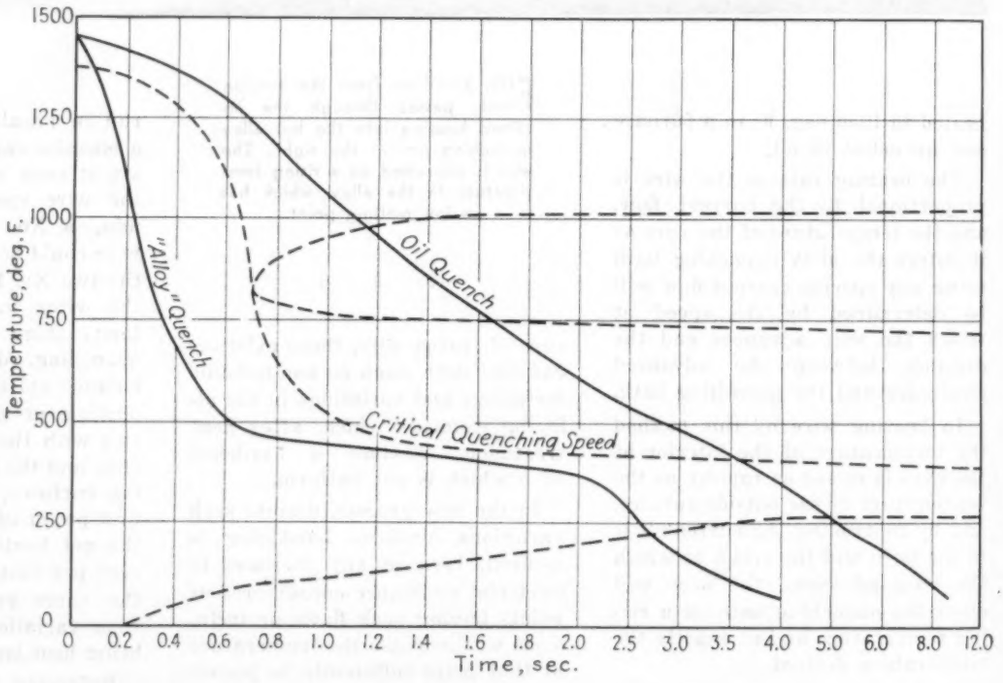

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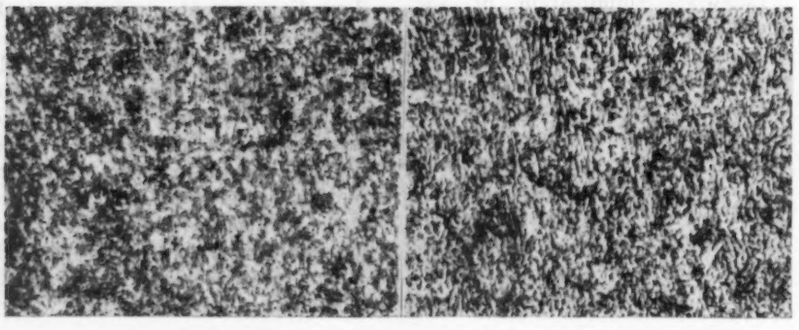
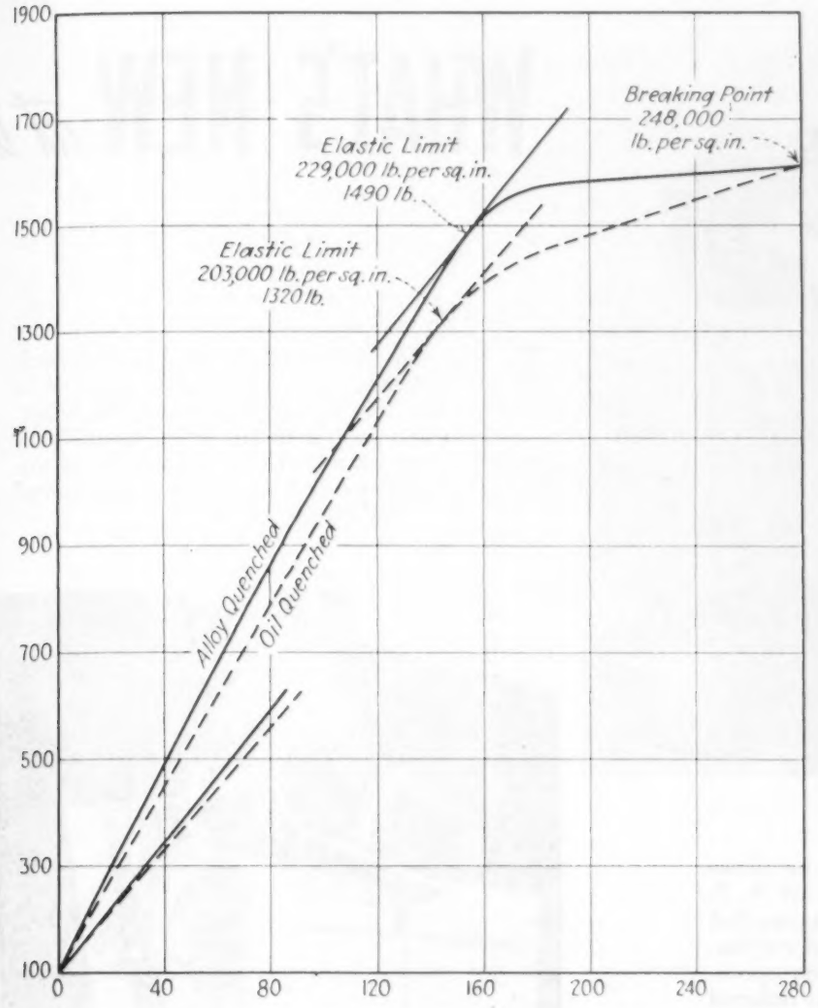
FIG. 7. — Photomicrographs at 2000 diameters of spring wire electrically heated and "alloy" quenched. Note the globular carbides in ferrite in the specimen on the left, and the crinkly martensite in the specimen on the right.





ABOVE

FIG. 9.—Spring wire having a hardness of 60 Rockwell C bent on itself. This photo at eight diameters demonstrates the remarkable bending qualities imparted by "alloy" quenching.

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AT LEFT

FIG. 8.—Stress-strain curve showing the elastic limit (Johnson) of 0.091 in. diameter wire.

conventional process. This improvement in physical properties is indicated in Fig. 4 and in Fig 9.

Fig. 9 shows the remarkable ability of the wire to withstand sharp bends. This particular wire has a hardness of 60 Rockwell C and yet can be bent flat on itself without fracture.

These properties are highly desirable in the manufacture of high grade springs, inasmuch as steel springs are usually highly stressed and subjected to very severe working conditions.

Spring wire is now being heat treated by the electric resistance method by the Cleveland Wire Spring Co. The advantages of this process are summarized as follows:

A product with higher physical properties and with greater fatigue and impact strength is obtained.

There is no surface decarburization and there is an absence of surface scale.

The wire has an excellent finish.

The thermal efficiency of the process is very high, in the neighborhood of 95 per cent.

The equipment is very flexible and is easy to operate.

There is an elimination of high temperature furnaces and lead pots with corresponding high maintenance costs.

The temperature of the wire being heat treated can be raised or lowered quickly and accurately.

The wire is quenched on a rising temperature and exactly at the temperature required instead of on a temperature that is falling, as in the conventional methods.

The control of heating and quenching cycles is very accurate.

TABLE I

Comparative Physical Properties for "Alloy" and Oil Quenched Wires

(Average of Six Tests)

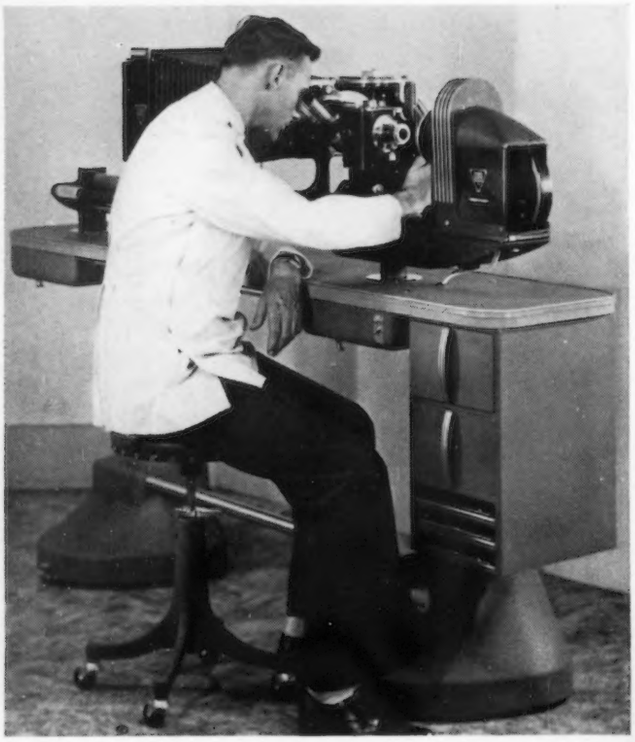
Wire	Diameter	Tensile Strength in Lb. Per Sq. In.	Elastic Limit, Johnson in Lb. Per Sq. In.	Per Cent Elongation 10 In.	Per Cent Elongation 2 In.	Reduction in Area in Per Cent	Torsion 10 In. No. of Twists	Hardness Rockwell C
1	0.091	248,000	203,000	3.4	6.3	53.0	16	47
2	0.091	248,000	229,000	3.1	5.2	54.8	25	48

Wire No. 1 furnace heated and oil quenched.

Wire No. 2 heated by electrical-resistance method and "alloy" quenched.

Analysis of steel: 0.63 carbon, 1.01 manganese, 0.017 phosphorus, 0.022 sulphur, and 0.19 silicon.

WHAT'S NEW *at the*

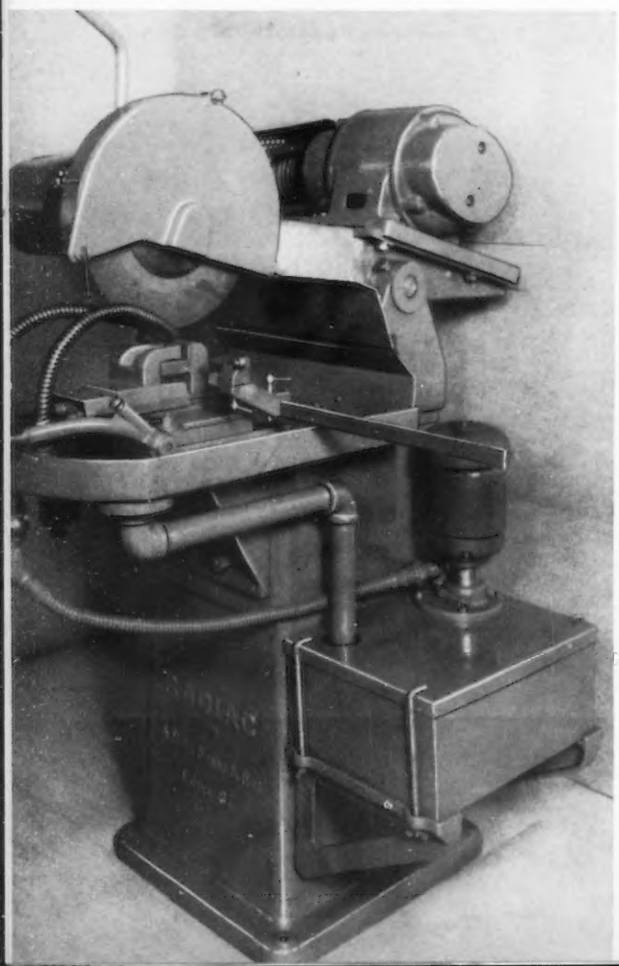


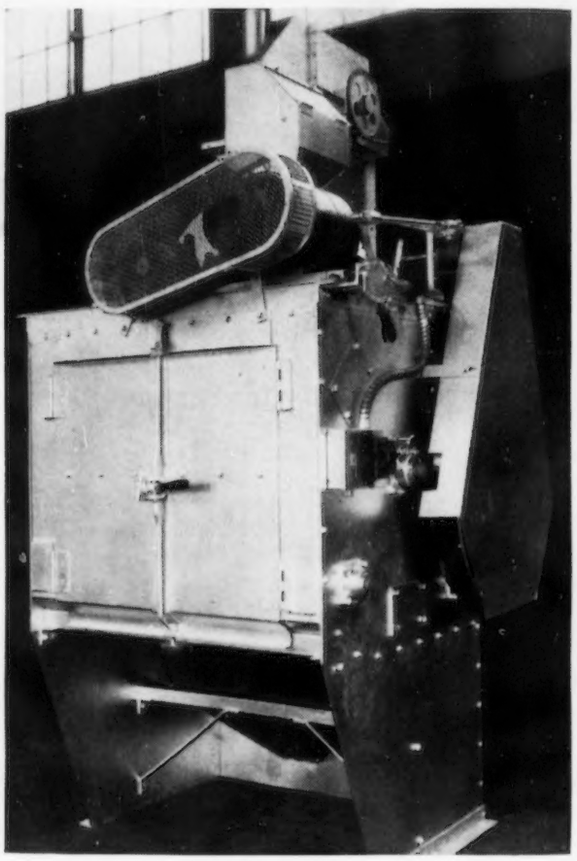
At Left . . .

THE new Bausch & Lomb Optical Co. research metallographic outfit will be demonstrated in Booth D-23. It is equipped for work with bright field polarized light, and dark field. Magnifying range is from a low limit of 2.5 diameters to the highest possible with oil immersion objective and high power eyepieces.

Below . . .

THIS radial cut-off machine will be shown for the first time at Booth L-5 of A. P. de Sanno & Son, Inc. Both the abrasive disk and the material are flushed with a continuous stream of coolant. Each cutting operation has a specific speed, and burr is reduced to a minimum.

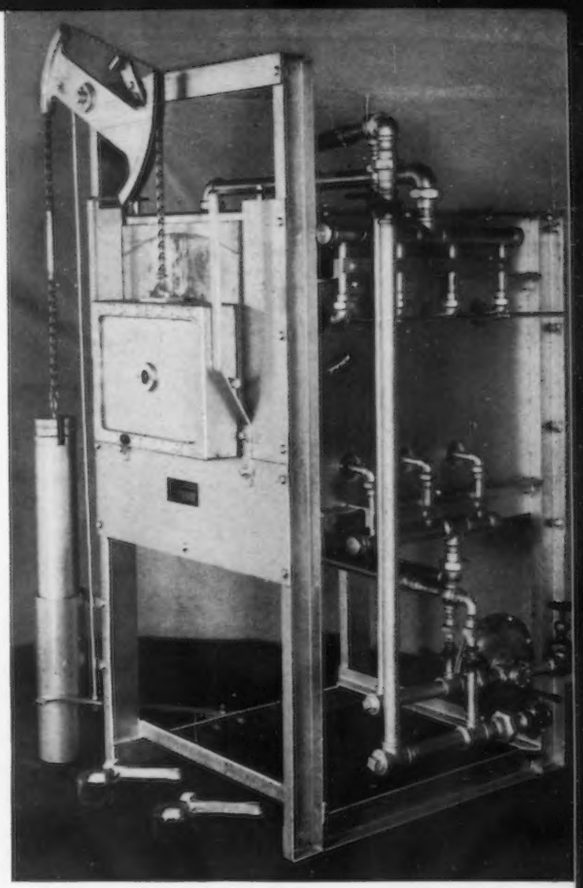




Above . . .

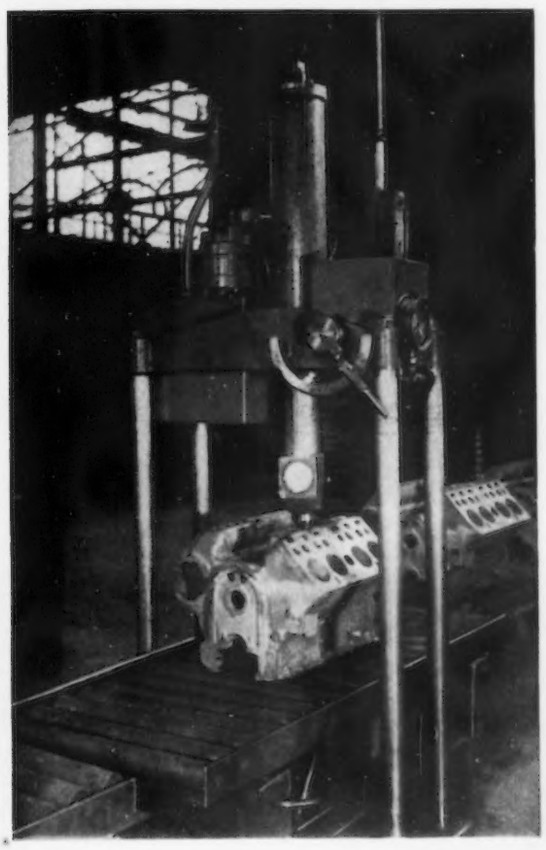
A NEW small Wheelabrator unit designed especially for use in foundries, shops and plants having a limited production will be shown in Booth M-48 of the American Foundry Equipment Co. Many new developments have been incorporated in the construction of this new airless abrasive unit.

METAL EXPOSITION ?



Below . . .

DETROIT Testing Machine Co., Booth N-54, is introducing this direct reading conveyor Brinell hardness tester. Readings can be obtained without elevating the specimens to a testing position. Grinding, spotting or use of microscope are not required.



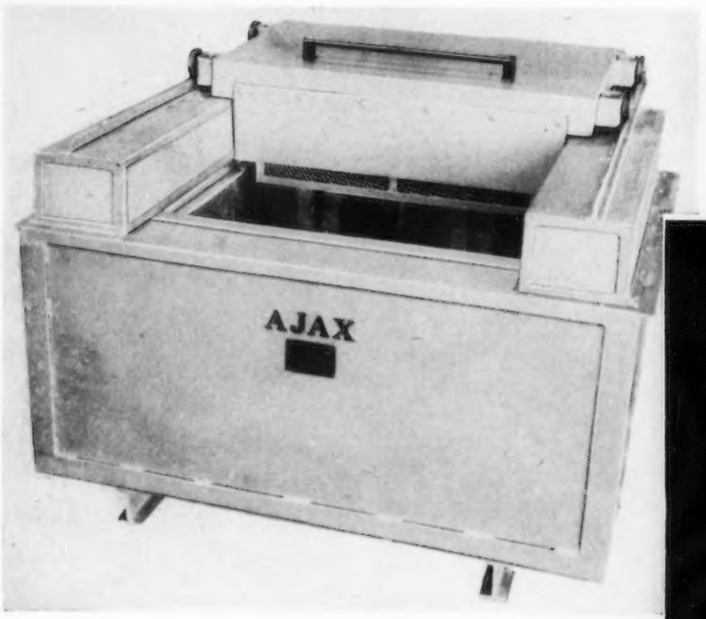
Above . . .

THE external appearance is unchanged, but this new oven heat-treating furnace is bottom vented, which is a decided departure from customary design. It will be exhibited in the gas section by American Gas Furnace Co.

At Right . . .

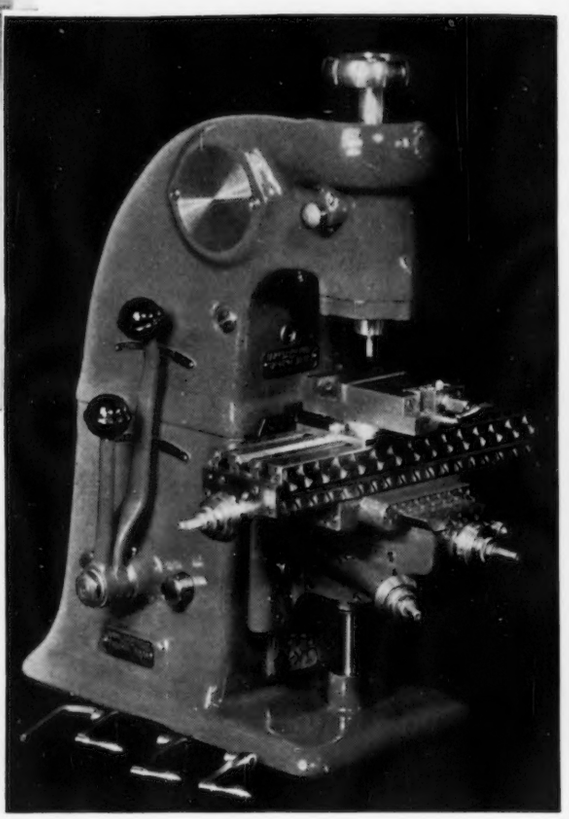
THE new "Shield-Arc S.A.E." welder of the Lincoln Electric Co. will be demonstrated in Booth F-23. This unit is first of a new line of single-operator machines and embodies a unique method of arc control which makes possible the adjustment of both arc heat and arc penetration in a continuous sequence of fine increments.

WHAT'S NEW *at the M*



Above . . .

A NEW and practical salt bath hardening furnace will be on display at Booth A-3, of the Ajax Electric Co., Inc. This Ajax-Hultgren furnace has a salt bath heated by its own resistance between electrodes within the bath. The pot is insulated. There is no fuel wastage and pot destruction is largely eliminated.

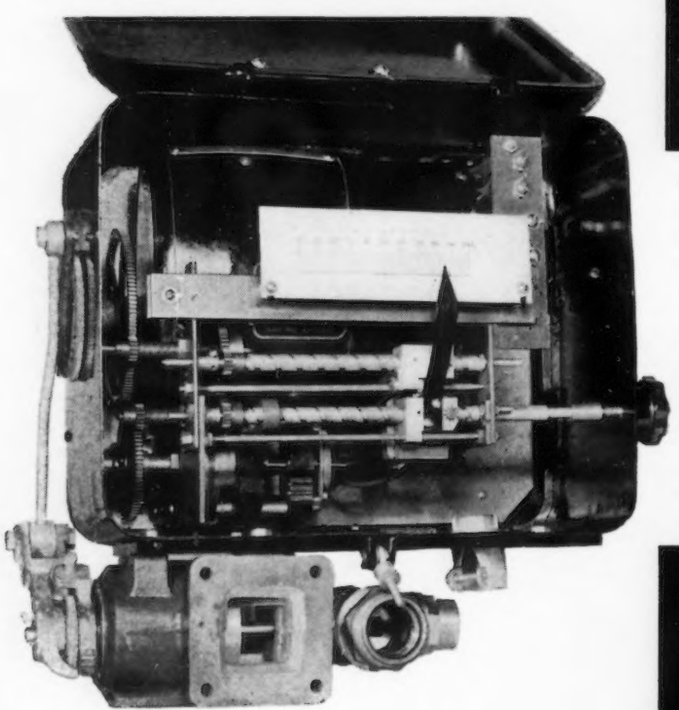


Above . . .

A NEW enclosed head bench type vertical milling machine will be on display for the first time in Booth L-14 of Hardinge Brothers, Inc. This machine has ball bearing spindle construction for high spindle speeds.

Below . . .

PRESSING, a new process in the aluminum industry, is advantageously used for the fabrication of aluminum magneto rotor covers, as shown in this picture. Other pressed parts will be shown by the Aluminum Co. of America in Booth I-23.



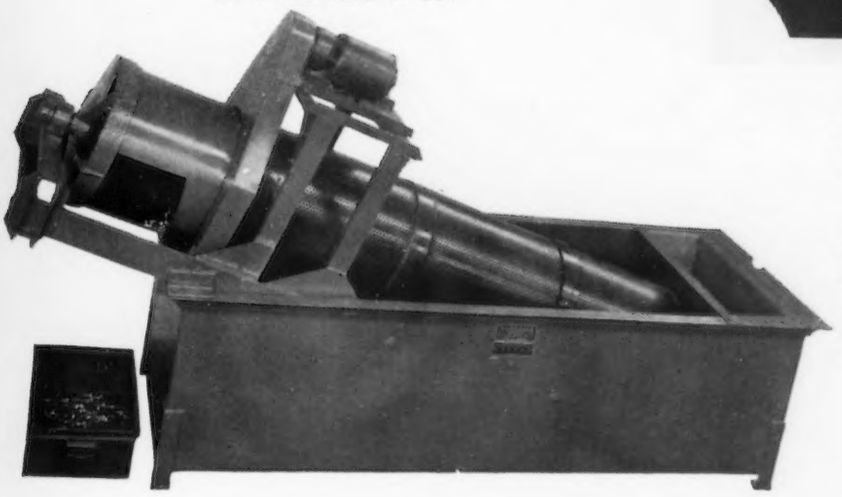
Above . . .

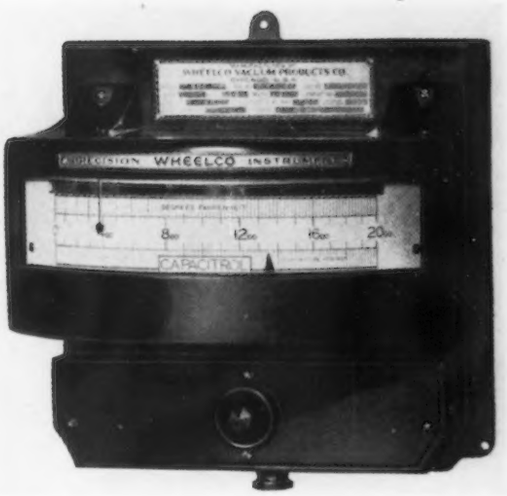
"TEMPERATURES, meet your master" will be the slogan of the Lindberg Engineering Co. for its display in Booth L-33. Particular emphasis will be given to the new "throttling control," an interior view of which is shown here. This fully automatic and redesigned unit is said to assure positive accuracy and uniformity in furnace heating rates, with no drift or wabble once it is set on a certain point.

METAL EXPOSITION ?

Below . . .

A NEW spiral quenching and washing machine for use in quenching parts after heat treating. Two or more units may be placed in tandem formation so that parts may be first quenched and passed into a similar unit for washing. For the first time this machine will be on exhibit at Booth L-51, of G. S. Blakeslee & Co.



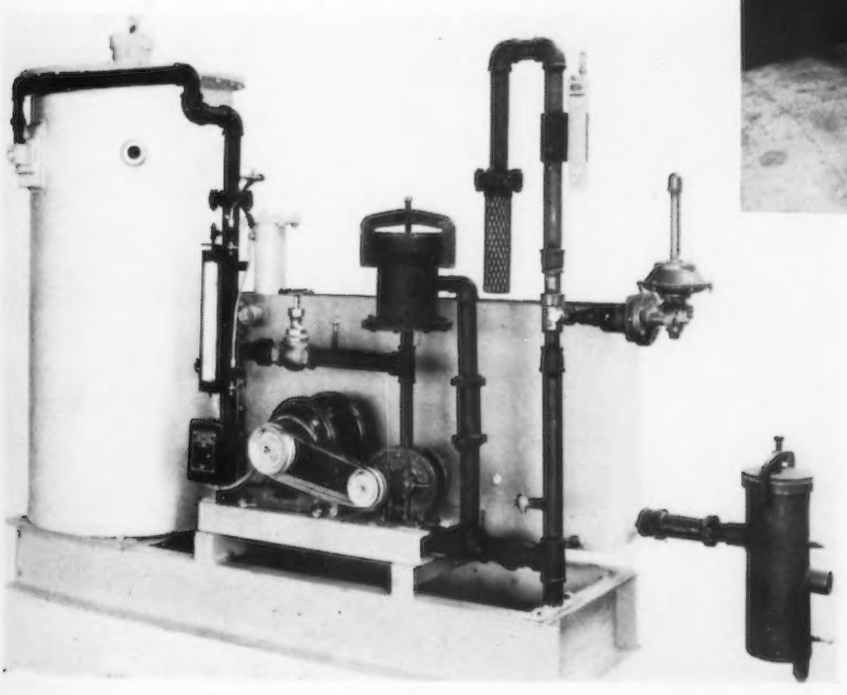


Above . . .

USING wave length variation for the energizing medium, this temperature controller has no cams, motors, mechanical parts and no contacts. It will be in operation in Booth I-32 of the Wheelco Instruments Co. It gives fine adjustment even when in the presence of vibration, dust, dirt, fumes and intense heat.

Below . . .

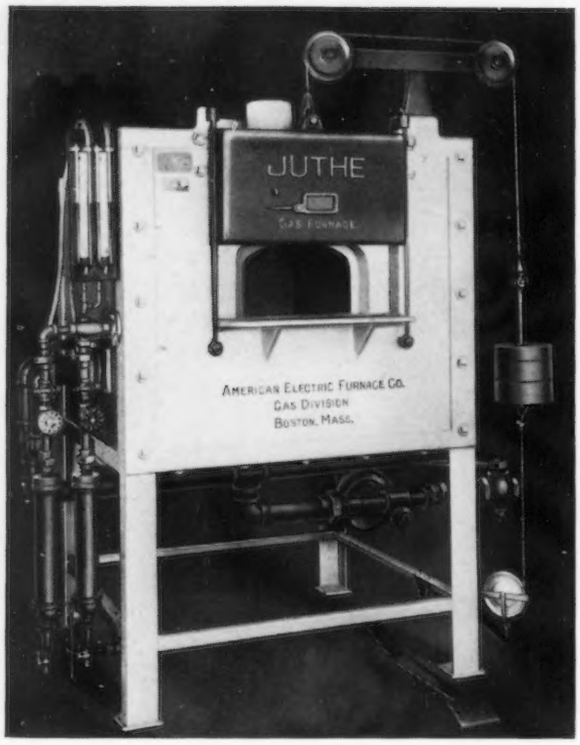
A NEW Elfurno generator for producing special atmospheres used in controlled atmosphere equipment is to be in operation in Booth L-21 of the Electric Furnace Co. These units can use natural gas, city gas, Butane, etc., and are built in sizes with capacities ranging from 100 cu. ft. per hr. up to almost any output required.



Above . . .

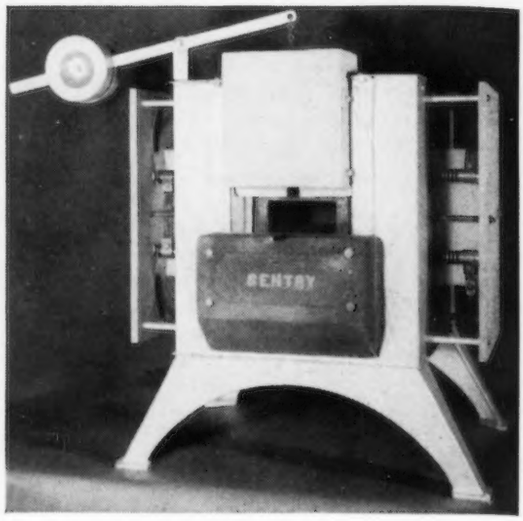
LINDE Air Products Co., Booth O-30, will have a display showing the advantages of columbium treated stainless steel welding rods. Also, a new Oxweld type CM-12 shape cutting machine, which is said to cover a scope of work hitherto impossible with one machine, will be in operation.

WHAT'S NEW *at the* ME



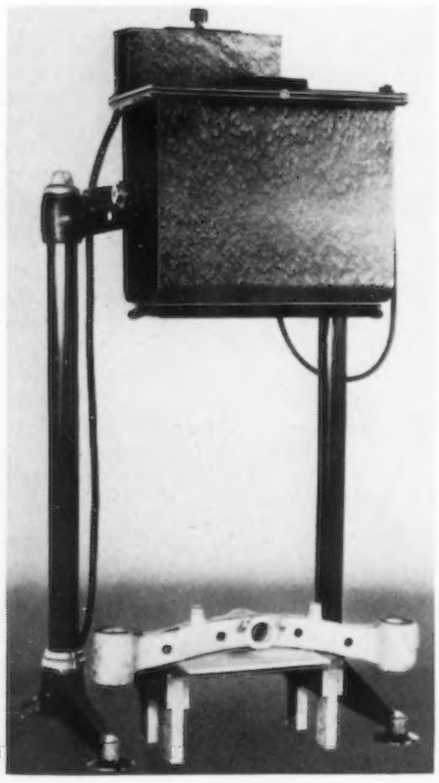
Above . . .

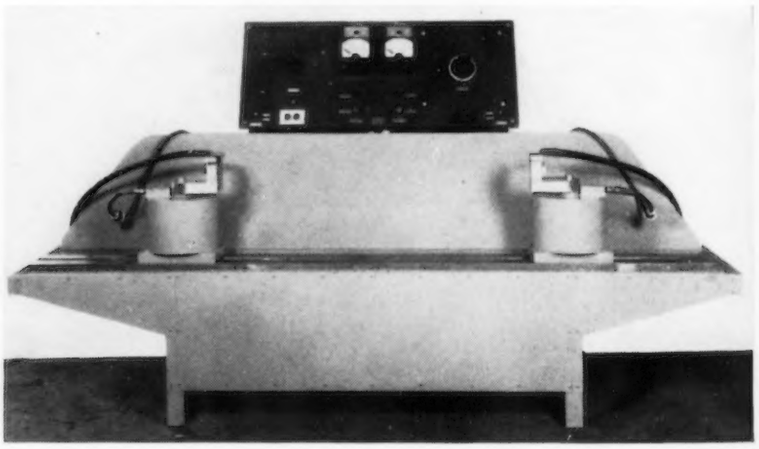
NEW developments in high speed gas furnaces and in preheat gas furnaces will be shown in Booth I-4 of American Electric Furnace Co. This new model has had the location of burners rearranged and there is a change in the design of the burner tunnels to provide for more uniform temperature distribution.



Above . . .

A RE-DESIGNED electric high speed steel hardening furnace will be in operation in Booth O-25 of the Sentry Co. Water cooling and complicated atmospheric control systems have been eliminated in this unit. Heating in this furnace is uniform and it will go to a temperature of 2350 deg. F. in less than one hour.





Above . . .

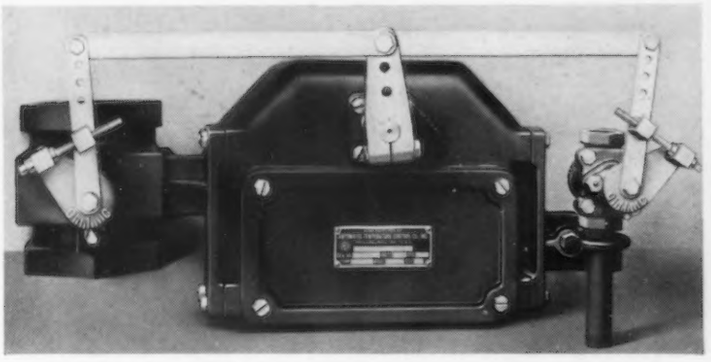
A NEW Magnaflux unit for detecting flaws in large crankshafts. An open grille table top covering a receiving tank permits inspection of parts by the wet method without removing the part from the unit. Tests will be conducted on this machine at Booth N-15 of the Magnaflux Corp.

o o o

At Left . . .

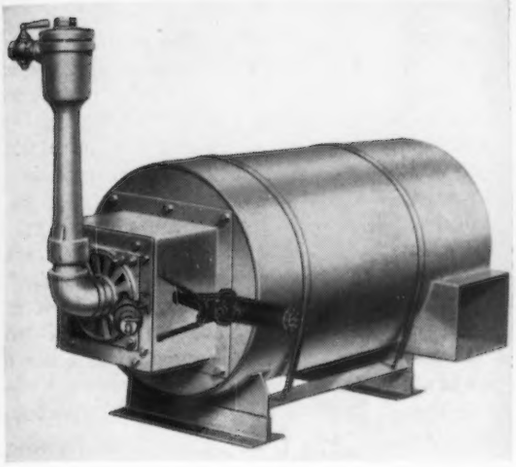
FOR radiographic inspection and examination of welds and castings of intermediate thickness, this new Model OX-1, 200,000-volt shockproof unit, has been developed by General Electric X-Ray Corp., and will be on exhibit in Booth E-21. This machine is small, accurate and sells at a low price.

the METAL EXPOSITION ?



Above . . .

THE Relatrol automatic temperature control system for fuel-fired furnaces makes small and graduated changes in the fuel rate which are exactly proportional to the temperature deviation from normal. Thus furnace atmosphere disturbance is kept to a minimum. This new type of Relatrol control, shown mounted with oil and air valves, gives a constant ratio of fuel to air at any per cent of opening. It may be seen in operation at Booth L-9 of Automatic Temperature Control Co., Inc.



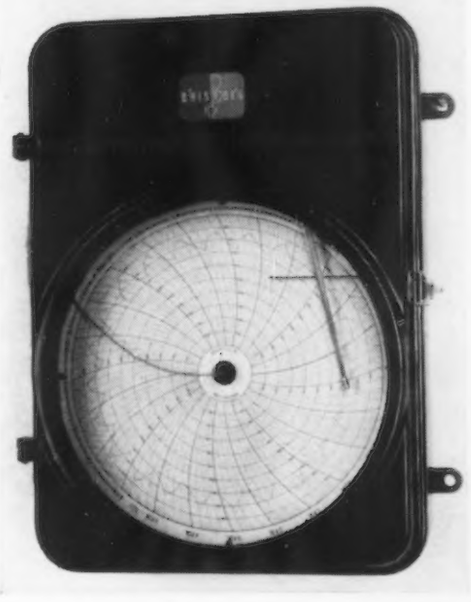
Above . . .

A RECENT development of Surface Combustion Co. is an air heater for temperatures as high as 1200 deg. F. Efficiencies as high as 50 per cent are not uncommon when used for heat treating, japanning, and core and mold baking. It will be operating in the gas section.

o o o

Below . . .

THIS recently developed luminous flame gas burner will be featured in Booth M-45 of the North American Mfg. Co. Various sizes burn from 400 to 3000 cu. ft. of natural gas per hr., and the flame developed possesses a high degree of luminosity which is unaffected by turbulence.



Above . . .

MANUFACTURED to provide lighter weight and higher efficiency in torch design, a new gooseneck type known as the Rego SX torch has been developed by Bastian-Blessing Co. It will be demonstrated in Booth L-19. The light weight permits high production on small parts without operator fatigue.

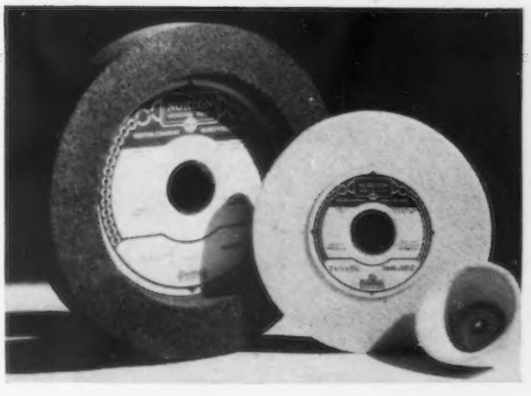
o o o

Below . . .

A NEW wheel for tool grinding has been announced by the Norton Co. and will be shown in Booths Q-12 and Q-16. The B-E bond wheel is said to give remarkably cool and free cutting action without sacrificing wheel life.

Above . . .

A PREVIEW of the new round chart potentiometer pyrometer of the Bristol Co. will be given in Booth L-15. All mechanical motion other than when a temperature change takes place has been eliminated. There is no pen drag, and, thus immediate response to changes exactly when and as they occur is assured.



Direct Rolled Aluminum

(CONTINUED FROM PAGE 33)

tension reeler will coil the strip on the other side of this three-high stand.

A 12-ton experimental lot of steel having an analysis of 0.04 C, 0.06 Si, 0.05 Mn, 0.005 P and 0.025 S has been run through a 12-in. direct-rolling mill, coming out about 0.065 in. thick and at a speed of 40 ft. per min. This particular lot of steel was subsequently cold rolled, and it performed entirely satisfactorily when fabricated into cans, screw caps and crown tops. Accompanying this article are several surface photomicrographs of this steel taken at 14 diameters with oblique illumination. The one shows the original oxide coated surface of the strip just as it leaves the direct-rolling mill. The other view shows the same surface after removal of the scale by pickling. There is no denying that this latter surface is about as satisfactory as could be expected and should easily work up into a highly finished sheet comparable to steel rolled down from ingots.

Also shown here is an etched longitudinal sample taken near the surface of the "as-rolled" strip and photographed at 100 diameters. Notice the fine grain which makes the steel particularly useful for deep drawing operations. After a laboratory normalizing treatment, this grain broke up into a considerably smaller size.

The steel as it leaves the direct-rolling mill has a hardness of about 71 Rockwell. The tensile strength varies between 52,700 and 60,320 lb. per sq. in., thus proving that the metal is not cast but has had considerable hot working. The per cent elongation in eight inches ranges between 11.2 and 16.2 and the per cent reduction varies from 23.2 to 55.3

Although Crown Cork & Seal Co. may hot dip some of its direct-rolled steel in tin, by far the greatest proportion will be coated with aluminum by a proprietary process recently perfected for commercial operation. By November the hot-aluminating equipment will be turning out 90 tons of coated steel daily, and, if necessary, another unit may be installed to increase production to above 150 tons daily.

Aluminum Coated Steel

For many years various workers both here and abroad have experimented with methods of applying aluminum to steel in a manner sufficiently satisfactory that it can take the place of tin plate for many applications. Potential advantages over tin as a coating are numerous. First, there is a tremendous cost differential; for aluminum sells for from 19 to 20c. per lb., as compared with a price of 45c. to 50c. per lb. for tin. A less obvious advantage is that one pound of aluminum will coat 2.5 to 3 times as much area as one pound of tin (aluminum is so much lighter than tin—the bulk ratio being almost 3 to 1). Both of these factors together indicate that actual metal cost for coating aluminum onto steel is about one-seventh that of tin for equal area covered.

Not only can aluminum plate supplant tin plate in many uses, but it is also a desirable substitute for zinc for coating iron, inasmuch as the chemical resistivity of aluminum is very high and it does not have an objectional poisonous nature typical of zinc. Aluminum is non-toxic and can be used safely in the food industry (canning), and such material can be treated by the anodic oxidation process which still further improves the corrosion resistance.

Crown Cork & Seal Co. first became interested in aluminum coated steel in an effort to secure a plated material which would stand up under the severe bends encountered in stamping crown cork seals. A crown of this type is sketched on page 27 of this issue. Note the very small radii of the bends which form the points of the crown and pinch the assembly onto the top of the bottle. Although tin plate has been used for crowns for many years, there have frequently been corrosion difficulties in service arising from partial failure of the tin coating at the points.

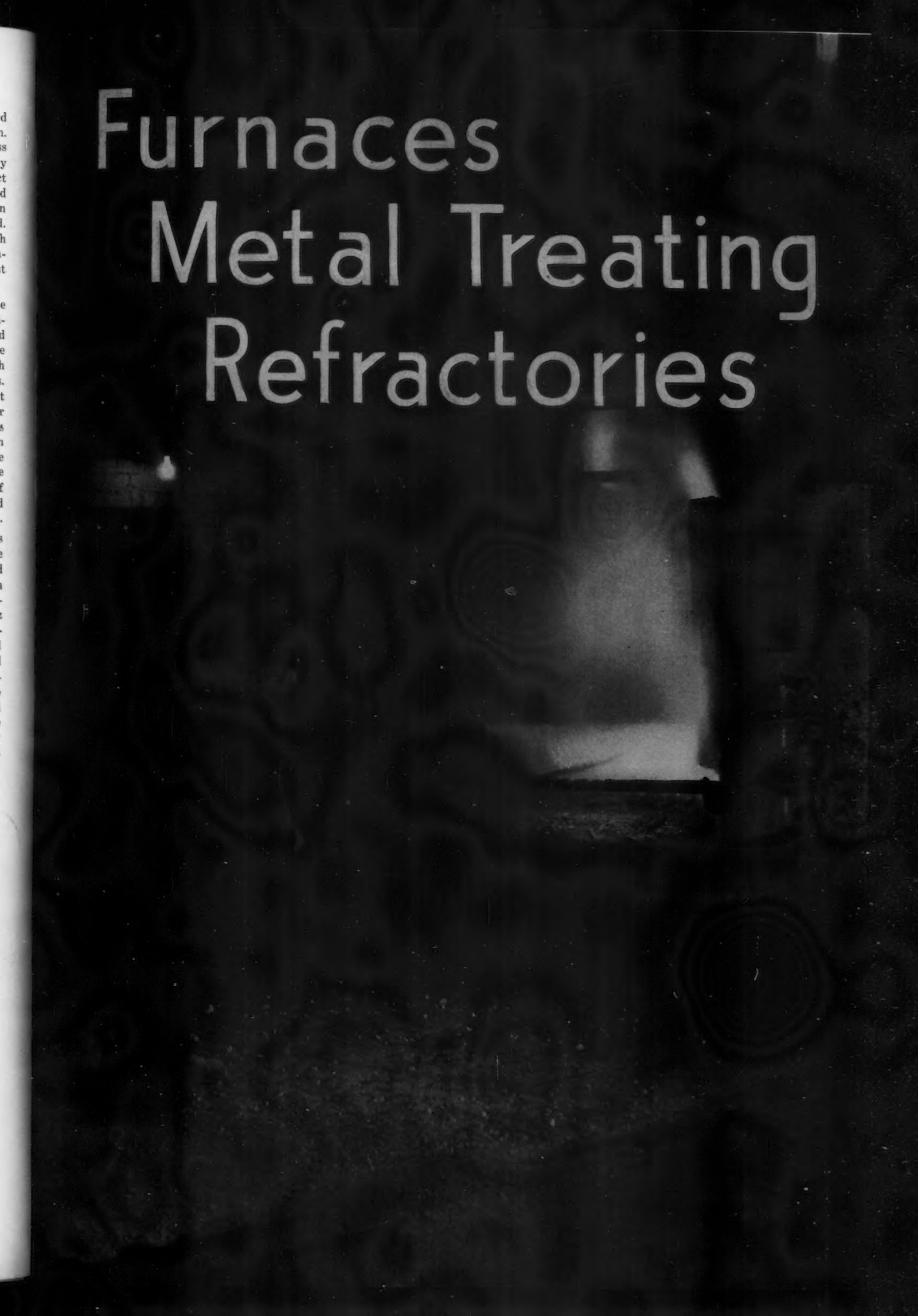
The hot dip aluminum coating on steel developed by Crown Cork & Seal Co. can be applied inexpensively and is highly satisfactory for making crown tops and also for the production of various containers and other incidental items such as screw tops for whiskey bottles, etc. In fact, a quantity of such tops have already gone into the market, and users have expressed considerable satisfaction with them. It is possible to vary the thickness of aluminum plate within very wide limits. The resulting product is ductile, that is, the alloy bond (Fe-Al) is not brittle, and adhesion of the coating is very pronounced. Sheets of steel thus coated with aluminum can be formed into intricate deep-drawn shapes without opening pores in the coating.

The writer has seen long-time corrosion tests comparing the comparative ability of tin plate and aluminum plate to withstand the ravages of atmosphere laden with moisture and industrial impurities. Tin plate specimens in this test showed distinct traces of rust after exposure for six months, whereas aluminum plate was unaffected. In fact the surface appearance of the aluminum plate was equal to the surface appearance of a plate of pure aluminum which was included in the test as a control specimen.

The Crown Cork & Seal process follows to some extent a few of the fundamental considerations laid down by other experimenters, such as Dellgren (Swiss patent 1,665,-061), C. G. Fink and Rodriguez (French patent 760,374), and involves a method whereby the steel is treated with some type of metal chloride or hot gas before immersion in the molten aluminum. The exact nature of this treatment will not be disclosed. Inasmuch as the Fink development is yet apparently confined to the laboratory, it appears that the Crown Cork & Seal has the only hot aluminating installation in this country now operating commercially.

Only a note can be given concerning the new alloy likely to be introduced soon by the Baltimore company. The information available indicates that the alloy will have a bauxite base and will be considerably lighter than steel but heavier than aluminum. It is said to be corrosion resistant, and stronger than tin mill black plate. Inasmuch as it is lighter than steel, it will take less weight to make a can of equal volume. On this premise, the new alloy will actually be produced in the Hazelett mill at a price under the current market level for tin mill black plate. This new alloy will not have universal application but will find considerable application in the fabrication of all types of packers' cans and beer containers.

Furnaces Metal Treating Refractories



Ovens for all Industrial Uses....

The
PAUL MAEHLER CO.
CHICAGO

NITRIDING

By V. O. HOMERBERG, Sc.D.*

AN accepted authority in the technology of the nitriding process, Dr. Homerberg herein presents an inclusive and integrated résumé of this hardening procedure and embellishes his manuscript with a sizable volume of new and heretofore unpublished data. One point emphasized by the author is that certain steels give very satisfactory results in applications in which line contact as well as point contact is involved. The experimental results disclosed are substantially correct as is proved by the mass of corroborative service data at hand.

THE nitriding process is by no means a panacea for all ills to which we should like to apply it. Nevertheless, nitrided material possesses certain well-established characteristics which make it highly desirable for applications involving high hardness and wear resistance, retention of hardness at moderately high temperatures and resistance to certain types of corrosion.

Not unlike other developments, nitriding had to pass through a certain evolutionary period before the applications of nitrided articles in industry could be properly determined and established on a permanent basis.

The term "nitriding" was suggested by the author to represent the nitrogen-hardening process disclosed by Dr. Fry. Before this term was proposed and accepted, the process was referred to under various designations, such as "nitrogenizing" and "nitrodizing." This suggestion was adopted and the Fry Process is now known as "nitriding" throughout the world. Processes for introducing both nitrogen and carbon at such high temperatures as to necessitate quenching to produce a hard case have been erroneously termed "nitriding."

The iron-nitrogen eutectoid forms at 580 deg. C. (1076 deg. F.), according to Dr. Fry. He recommended that nitriding should be done below this temperature in all steels in which this eutectoid was likely to form. In the alloy steels evolved for obtaining the highest degree of hardness in case-hardening with ammonia, it would be highly desirable to introduce

*Associate professor of physical metallurgy, Massachusetts Institute of Technology, Cambridge, Mass., and technical director of the Nitralloy Corp., New York.

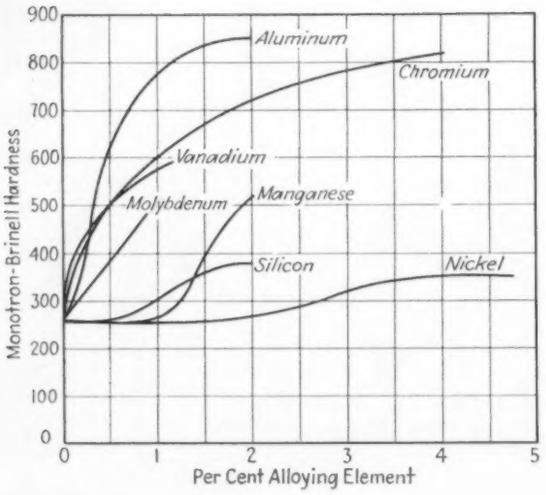


FIG. 1 — Individual influence of seven different elements on the maximum hardness of nitrided steels. It is obvious that chromium is the best substitute for aluminum.

sufficient nitrogen to combine only with the alloying elements, since iron-nitride forms after this has taken place. Since this condition is not easily obtained, the eutectoid temperature manifested in the iron-nitrogen system still retains its significance in the nitriding operation, although it may be affected to a considerable extent by the addition of alloying elements.

In the early introduction of the nitriding process, the author stated that, in his opinion, the great hardness obtainable was due to the formation of complex nitrides which are in dispersion corresponding possibly to "critical dispersion."

Dr. Fry[1] has called attention to the fundamental difference between the mechanism of the nitriding process from that of case-hardening by carburization. In the latter process, carbon is soluble in the matrix at the carburizing temperature and can therefore gradually penetrate from the outer to the inner layers by diffusion, whereas in nitriding the insoluble compounds formed between the active nitrogen and the alloying elements render such penetration impossible. As the nitriding process progresses, the absorbed atoms of active nitrogen are forced to penetrate an already saturated layer of increasing thickness. The fixed nitrides have a constraining effect on the further penetration of the active nitrogen, thereby causing only a comparatively shallow case to form even after a considerable time of exposure.

Norton[2] studied the mechanism of nitriding when applied to iron-aluminum alloys. He concluded that the hardening effect was due to the precipitation of aluminum nitride particles in a finely divided form.

The investigations by Fry and Norton tend to substantiate the original opinion of the author to account for the hardness produced by nitriding.

The steels that were first introduced for nitriding contained combinations of aluminum and chromium. Molybdenum was later added to overcome any tendency toward "temper brittleness" and to increase the toughness of the case. These steels are the ones most widely used at the present time. Two of these steels, together with one which contains no chromium, have the compositions shown in Table I.

Nitralloy is heat treated before nitriding in order to produce a sorbitic structure. In this condition the most desirable case and core properties are obtained for most applications.

The physical properties for Nitralloy 125 and 135 are given in Table II.

A modified Nitralloy 135 composition that is being widely used, especially in aircraft for cylinder barrels, reduction gears, etc., shows an increase in carbon, chromium and molybdenum over the regular Nitralloy 135. Its analysis is 0.38 to 0.45 carbon, 1.40 to 1.80 chromium, 0.75 to 1.30 aluminum, and 0.30 to 0.45 molybdenum. Higher physical properties than those for Nitralloy 135 are obtained, together with a somewhat better machineability, the latter being due to the increased molybdenum content.

Effect of Individual Elements

French[3] and Homerberg have shown that the presence of nickel in nitriding steels tends to strengthen and toughen the case with moderate decrease in case hardness. It also strengthens and hardens the core, thereby providing better support for the case. It develops dispersion hardening in steels containing appreciable proportions of aluminum, by means

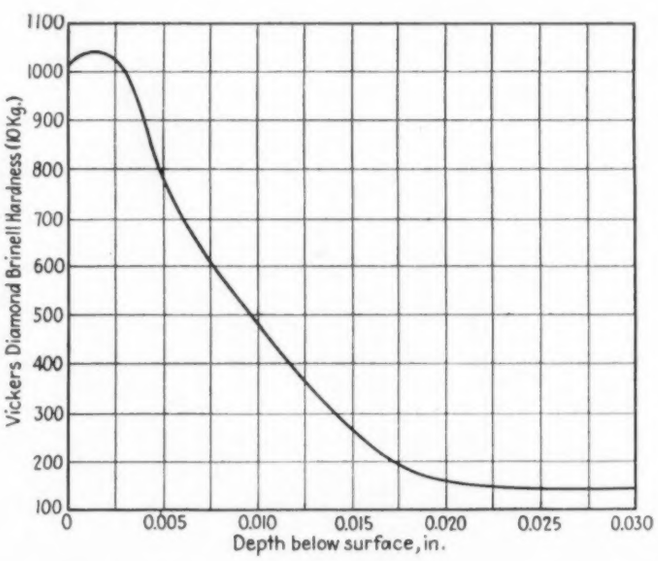


FIG. 2—Depth-hardness values for nitrided Nitralloy containing selenium. This metal, designated as Nitralloy EZ, has a full analysis as follows: 0.34 C, 0.76 Mn, 0.17 Si, 1.36 Cr, 0.033 S, 0.020 P, 1.13 Al, 0.22 Mo, and 0.28 Se.

[1] Dr. A. Fry: "Theory and Practice of Nitrogen Case-Hardening," *Journal of the British Iron and Steel Institute*, vol. 125, No. 1 (1932).

[2] J. T. Norton: "X-ray Study of the Action of Aluminum During Nitride Hardening," Transactions, A.I.M.E., vol. 113 (1934).

[3] H. J. French and V. O. Homerberg: "Role of Nickel in Nitriding Steels," Transactions, A.S.S.T., 1932, No. 6, vol. 20, p. 481. THE IRON AGE, 1932, vol. 130, p. 534.

of which articles may automatically acquire higher core strength and elastic properties during nitriding.

As an example of service results obtainable with the nickel-containing Nitralloy (essentially Nitralloy 125 or 135 with 3½ per cent nickel), roll thread dies made from this steel produced 50 per cent greater number of screws than did high-carbon high-alloy steel dies. (*Nickel Steel Topics*, June, 1936.)

French and Homerberg made a careful study of the nitridability of steels containing individually the various alloying elements. Steels containing combinations of these elements were also investigated. The effect of the individual elements on the maximum hardness obtained after nitriding at 975 deg. F. for 48 hr. is shown in Fig. 1. It is significant that little is to be gained by increasing the aluminum content over 1 per cent and that about 3 per cent of chromium in a plain carbon steel produces the same effect as about 1 per cent of aluminum.

Although steels containing only aluminum or chromium are of no particular interest for nitriding, it is apparent from the curves in Fig. I that chromium in suitable amounts may act as the most logical substitute for aluminum in non-aluminum nitriding steels.

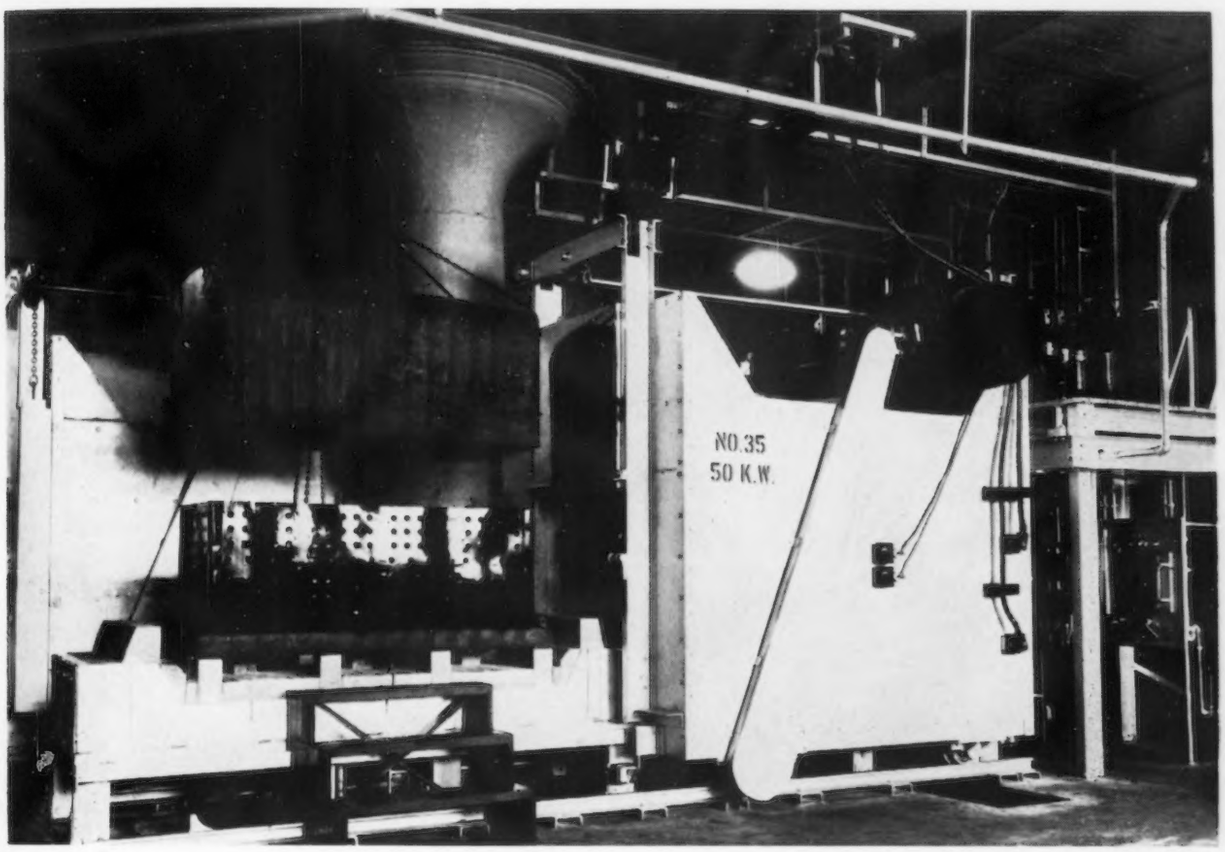


FIG. 3—One of a battery of nitriding furnaces used by Wright Aeronautical Corp. The furnace is movable and may be placed over either of the two nitriding containers mounted on the hearth.

The nitriding of non-aluminum steels containing principally combinations of chromium, molybdenum and vanadium has been thoroughly investigated in the laboratories of Aubert and Duval Freres in France and in the Fried, Krupp Co. in Germany.

Strauss[4] and Mahin also investigated the nitriding of non-aluminum steels and recommended certain chromium - molybdenum - vanadium steels for this purpose. These steels contain about 0.5 per cent Mo and 0.20 V with variable amounts of Cr—those particularly studied containing 2.5, 4.5 and 6 per cent of chromium. A Vickers hardness of approximately 1000 was obtained after nitriding the steel containing 4.5 per cent chromium.

Special steels are being nitrided for applications requiring high core hardness to support the nitride case. Many of these steels have been discussed by Emmons[5]. Nitrided cobalt-chromium steel and the service results obtained have been discussed by Knerr[6].

Lieutenants Sylvester and Whiteside[7] studied in considerable detail the nitriding of a number of steels of this character. The compositions of those studied, together with the nitriding data obtained, are given in Table III.

These steels were heat-treated in accordance with the recommendations of the manufacturers. The nitriding was done at 950, 975 and 1000 deg. F. for 36, 48 and 72 hr., after which the hardness and depth of case were obtained on taper ground specimens. Only the data for the time period and the temperature at which maximum hardness was obtained are given in Table III.

Merten[8] recommends a steel of

[4] J. Strauss and W. E. Mahin: "Nitriding Characteristics of Cr-Mo-V Steels," *Metals and Alloys*, vol. 6, No. 3 (1935).

[5] J. V. Emmons: Patents No. 1,982,421 and 1,982,422.

[6] H. C. Knerr: "Nitrided Tool Steels," THE IRON AGE, Sept. 26, 1935.

[7] Lieutenants Sylvester and W. S. Whiteside: "Experiments on Nitriding Tool Steels," M.I.T. Master of Science Thesis, 1936.

[8] Private communication.

the following composition for use as a roll for hot-rolling after nitriding: C, 0.55 to 0.70; Cr, 4.00 to 5.50; V, 0.45 to 0.60; and Mo, 0.90 to 1.10.

Merten claims that this steel after proper heat-treatment and followed by nitriding, will not heat check and will produce a roll of suitable structural, physical and chemical stability to withstand the temperatures and pressures developed during hot-rolling.

In Europe, Nitralloy containing a low aluminum content (approx. 0.50 per cent) is being used extensively. Although a lower surface hardness is obtained after nitriding, it has been found to be sufficient for most applications. It produces a tougher case, which is therefore less susceptible to spalling than the Nitralloy with the customary 1 per cent of aluminum.

Nitriding steels containing a high sulphur content can be used to advantage whenever free machining is highly desirable and when maximum impact properties are unnecessary. The nitridability of these steels is not affected by the presence of sulphur.

Nitralloy containing selenium is also being used for applications requiring maximum machineability, such as in automatic screw machines, etc. Nitralloy 135 with 0.15 to 0.25 per cent selenium is most commonly used for this purpose. Fig. 2 shows the depth-hardness curve of such a steel after nitriding for 48 hr. at 975 deg. F.

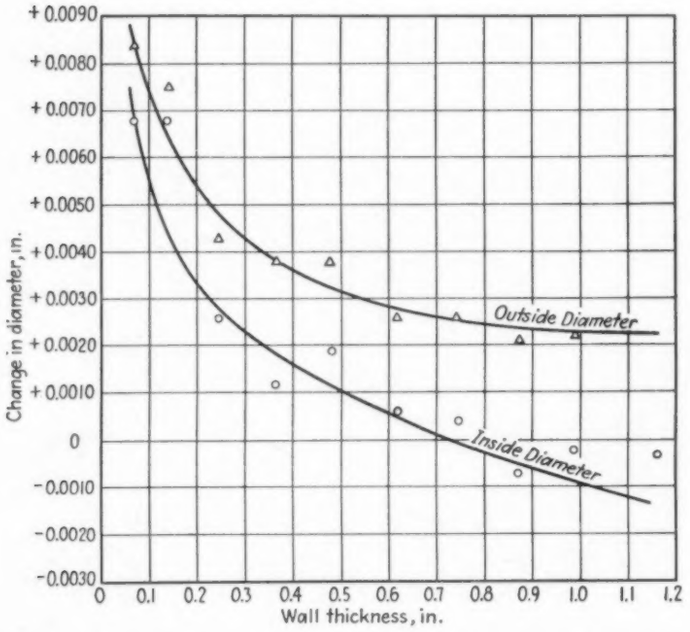


FIG. 4—Growth in rings or cylinders of Nitralloy 135 due to the nitriding procedure.

Considerable attention has been given to the nitriding of austenitic steels by Jones[9]. The steels investigated by him were of the nickel, chromium-nickel, chromium-nickel-tungsten, manganese and nickel-manganese types. A temperature of 500 to 510 deg. C. (932 to 950 deg. F.) with a nitriding period of 90 hr. was employed. With some steels, certain modifications of the usual process were made, such as a variation in the ammonia dissociation, nitriding at a higher pressure than usual and changing the character of the surface of the steels precedir ; the nitriding treatment by pickling in acid or by copper plating.

Nitriding of Austenitic Steels

The high manganese austenitic steels were readily nitrided with a Vickers hardness up to 1000 according to the manganese content. Steels containing 18 per cent manganese gave the maximum surface hardness.

Chromium-nickel austenitic steels did not harden consistently until the protective oxide surface film was removed. Pickling the steels in a 50 per cent solution of hydrochloric acid resulted in a marked improvement in hardness, especially in steels of the 18-8 Cr-Ni composition. It was found that the oxide film re-formed in local areas on the surface of some of the steels and, after nitriding, showed a dull exterior where the steel had hardened and a shiny area where it

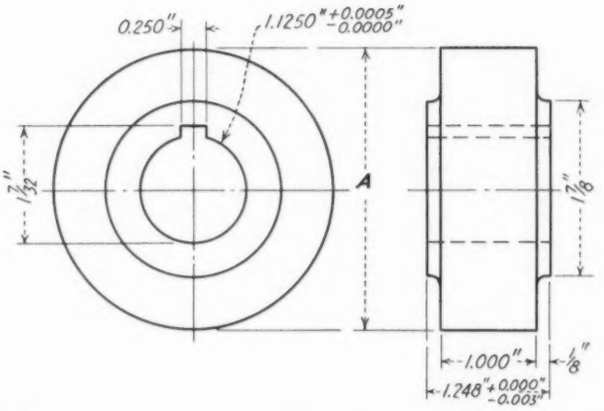


FIG. 5—Dimensions of test disk used to determine surface endurance of nitrided steels. This specimen is used on the testing apparatus shown in Fig. 6.

[9] B. Jones: "Nitriding Properties of Some Chromium and Austenitic Steels at a Temperature of 500 Deg. C.," British Iron and Steel Institute, Carnegie Scholarship Memoirs, vol. 22 (1933).

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had not hardened. Better and more consistent results were obtained with these steels when nitrided under higher pressures. Steels of the 18-8 type gave substantial increases in hardness after copper plating, although the results were no better than those obtained with the pickled steels. Nickel-manganese and nickel-chromium-tungsten steels were found to harden appreciably when copper-plated prior to nitriding.

commonly used in this country has the following approximate composition: 0.45 per cent C, 14.0 Ni, 14.0 Cr, 2.5 W, and 0.30 Mo.

The usual practice is to treat the articles with 50 per cent hydrochloric acid and then nitride at 1100 deg. F. for 50 hr. to produce a case depth of about 0.005 in. with a Vickers hardness of 700 to 750.

Steels containing beryllium, both

are available. These furnaces have been described by Roth[10], Lapelle[11], and Cowan[12]. The Homo nitriding furnace is too well known to require description. The essential requirement is that the furnace must maintain a uniform temperature within the nitriding container.

Fig. 3 shows one of a battery of furnaces used by the Wright Aeronautical Corp. This furnace con-

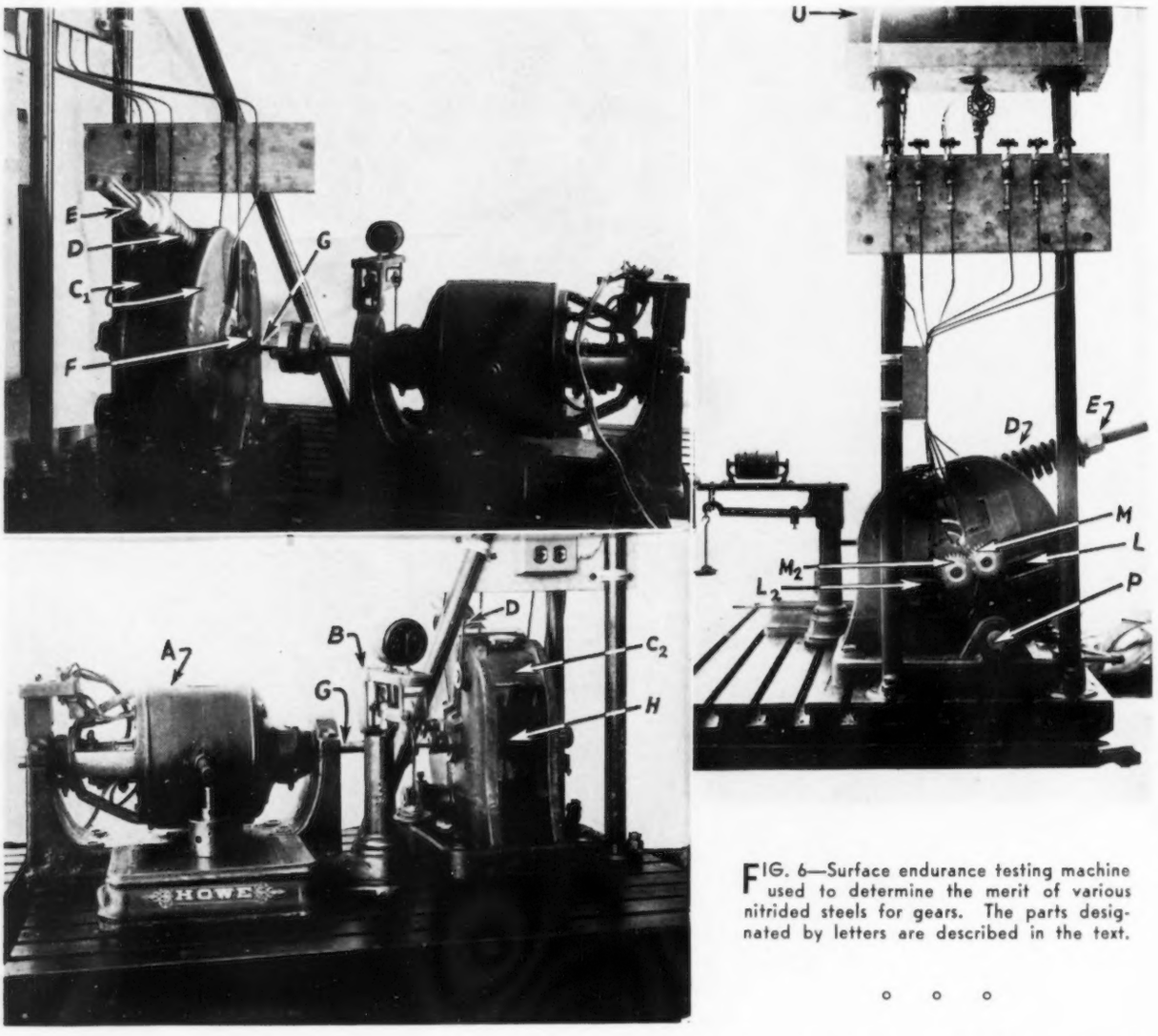

FIG. 6—Surface endurance testing machine used to determine the merit of various nitrided steels for gears. The parts designated by letters are described in the text.

o o o

Austenitic steels that contained only nickel as an alloying element did not harden by nitriding, although the nitrogen penetrated the material without difficulty.

The nitriding of the stems of austenitic aircraft valves is common practice. The alloy most

the ferritic and the austenitic types, can be precipitation-hardened and nitrided. It is possible to harden the core to a high degree by the precipitation of a beryllium-iron compound and to nitride the surface so as to procure a very hard case. Steels having the combination of high case hardness and high core hardness are important in applications where resistance to high surface stresses is of paramount importance.

Special furnaces for nitriding

sists of a movable furnace chamber which is mounted on track wheels and located above a stationary hearth. Two nitriding containers are mounted upon this hearth. A hand-operated crane is provided by which the operator may readily move the furnace chamber back and forth over either of the containers.

The use of a stationary hearth permits the use of permanent pipe connections from the ammonia tanks. The exhaust gas from the

[10] W. Roth: "Nitrogen Hardening," Metal Progress, 1932, No. 5, vol. XXI, p. 40.
[11] R. R. Lapelle: "Low Cost Production Nitriding in a Novel Furnace," THE IRON AGE, 1932, vol. 129, p. 874.
[12] R. J. Cowan: "Continuous Nitriding, a New Development," Metal Progress, 1930, No. 4, vol. 18, p. 93.

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container undergoing heating may be used to maintain the proper atmosphere in the second container during the cooling cycle and for expelling the air after recharging. Fans are used to promote ammonia circulation.

The nature of the container material is of paramount importance. If a nitride surface can form on the container wall, it may act to

ganese, and nickel-chromium alloys such as an alloy of 62 per cent nickel and 12.5 per cent chromium, are being used successfully. The containers and covers used in the furnace previously described are made from an alloy of the following composition: 0.25 per cent maximum carbon, 19 to 21 nickel, 24 to 26 chromium, and 0.70 to 1.50 per cent silicon.

nitriding equipment cannot be overemphasized.

Although various nitriding temperature cycles have been recommended, the common practice is to nitride at a single temperature from 930 to 1000 deg. F. depending upon the requirements. The lower temperature is most commonly used in Europe, while 960 to 975 deg. F. is the common range here.

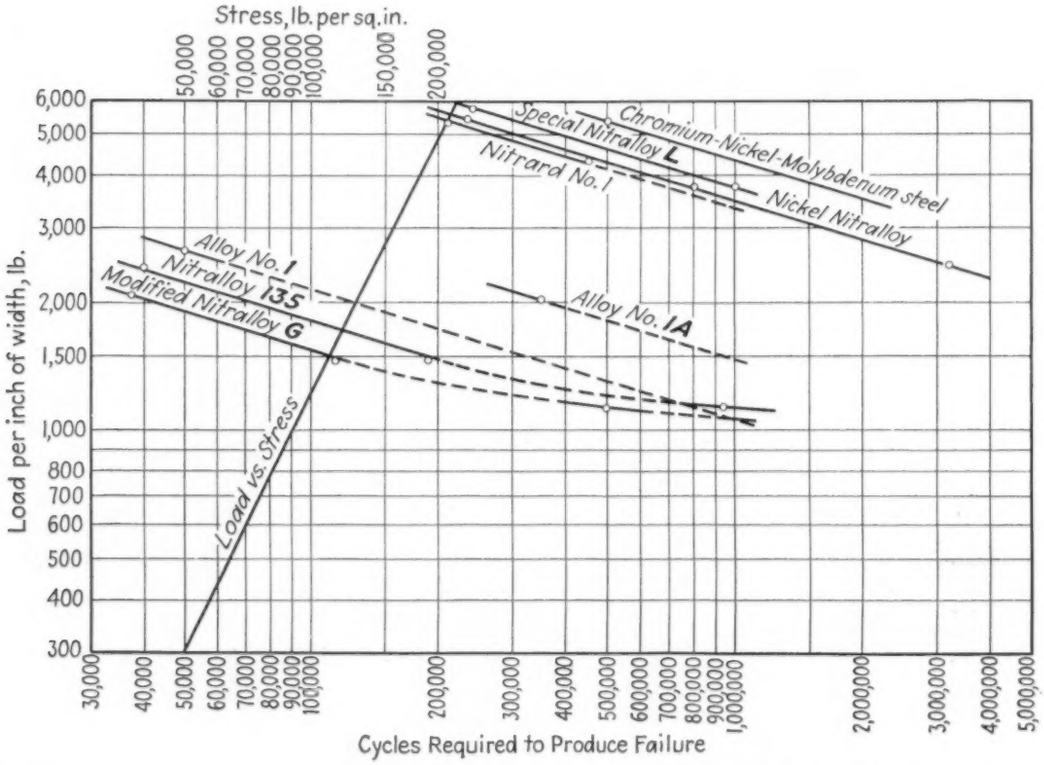


FIG. 7—Surface endurance of nitrided steels. The nickel-containing Nitralloy not only has a very high surface hardness but also stands up remarkably well in this type of test.

catalyze the ammonia in contact with it and thereby prevent the proper nitriding of the articles. In such a case, the determination of the ammonia dissociation is not indicative of the amount dissociated by contact with the steel parts. It is the atomic nitrogen in immediate contact with the steel parts that is responsible for the nitriding.

Nickel, Monel metal low in man-

All parts exposed to the ammonia gas in this unit are enameled. This coating presents an inert surface and is highly desirable from this standpoint. The only objection to its use is a tendency to chip when struck by parts during the charging operation. The composition of the alloy, however, is such that the container will suffer very little, if any, in its effect on the nitriding operation in case that chipping takes place.

Nitriding Cycles

The use of unsuitable container materials will lead to poor nitriding results and the use of an abnormal amount of ammonia. Proper attention to this part of the

Sergeson[13] advocates the use of a temperature of 950 to 1000 deg. F. followed by a nitriding temperature of 1150 to 1200 deg. F., whereby he claims the production of a tougher case than if only the lower temperature is used. Other cycles have been recommended by McQuaid[14], Merten[15] and by Harsch and Muller[16].

Kontorovich[17] has reported on the work done in Russia at the Research Institute for Aircraft Metals. Assuming that the concentration of nitrogen at the surface and its speed of diffusion are proportional to the temperature, a three-stage process was tried. The first stage was to nitride at 930 deg.

(CONTINUED ON PAGE 61)

[13] Robert Sergeson: "Investigations in Nitriding," Transactions, A.S.S.T., 1929, vol. 16, p. 145.
[14] H. M. McQuaid: "Process of Surface-Hardening Steel," U. S. Patent No. 1,804,176, 1931, May 5.
[15] W. J. Merten: "Mechanism of Nitriding and Nitriding Practice," Fuels and Furnaces, 1931, vol. 9, p. 675.
[16] J. W. Harsch and J. Muller: "Deep Nitriding by Program Control," Metal Progress, 1932, No. 1, vol. 21, p. 74.
[17] J. E. Kontorovich: "Rapid Nitriding of Steel," Metal Progress, vol. 27, No. 2, 1935, p. 43.

(CONTINUED FROM PAGE 56)

F. to produce nitride dispersion. This was followed by the second stage at 1100 to 1200 deg. F. to obtain a high nitrogen content at the surface and to speed the diffusion inward. The third stage consisted in dropping the nitriding temperature back to 930 deg. F., in which case it is believed that the rate of saturation of the outer layers with nitrogen is slower than the rate of diffusion and thus reduces the concentration gradient and the brittleness of the surface.

Parts are being nitrided commercially in Russia by this method in one-half to one-third the time required at 900 deg. F. and 65 to 70 per cent of the ammonia is dissociated instead of the customary 30 per cent. There is a gradual decrease in hardness from the surface to the core and the surface is free from brittleness.

An experiment was conducted to determine the effect of repeated heating and cooling on the characteristics of the nitride case.

Specimens of Nitralloy 135 were nitrided at 975 deg. F. for 72 hr. The case depth was 0.029 in. after this treatment.

The nitrided specimens were heated to 800 to 2000 deg. F. at intervals of 200 F. deg., after which they were quenched in air, oil and water. After each heating and cooling, the specimens were examined visually and after each five cycles they were examined with a binocular microscope for checks or cracks in the case. After each quenching the samples were again placed in the furnace, which was at the desired temperature, and after becoming heated throughout they were again quenched. This cycle was repeated until cracks or checks developed. A maximum of 50 cycles of heating and cooling was used. Hardness readings were also taken.

Hubbard and Robinson[18] concluded from these tests that—

(1) The nitride case will withstand repeated heating and cooling from 1000 deg. F. or below, even after quenching in water.

(2) The case will not be affected by repeated quenching in air or oil from 1200 deg. F. (Only a slight loss in hardness was noted.)

(3) Repeated heating to and cooling from 1400 deg. F. and higher will cause the case to crack and become rapidly damaged.

Internal Growth of Hollow Cylinders

A variation in the internal growth takes place in the nitriding of rings or hollow cylinders. In order to procure data on this subject, Hubbard and Robinson[18] determined the change in dimensions of hollow cylinders with varying wall thickness. The outside diameter of the specimens was 2¾ in., with wall thicknesses of 1/16, ⅛ and up to 1¼ in. at ⅛-in. intervals.

The specimens were rough-machined after quenching from 1725 deg. F. followed by tempering at 1300 deg. F. for three hours. After leaving ⅛ in. for final grinding, the hollow cylinders were given a stress relief by heating at 1000 deg. F. for three hours, after which they were ground to final dimensions. Measurements of inside and outside diameters were made, using micrometers reading to 0.0001 in. The specimens were nitrided at 975 deg. F. for 72 hr., after which the second set of measurements was taken.

The results of this investigation are shown graphically in Fig. 4.

It will be seen that, as the wall thickness increases, the change in outside diameter tends to approach a constant value (as does the change in inside diameter, probably). As the wall thickness de-

[18] Lieutenants H. E. Hubbard and J. M. Robinson: "Investigations of Nitriding Steels and Their Application for Use in Torpedoes," M.I.T. Master of Science Thesis, 1934.

TABLE I

Analysis of Three Common Nitriding Steels

	Nitralloy 125 ("H")	Nitralloy 135 ("G")	Nitralloy 230
Carbon	0.20 to 0.30	0.30 to 0.40	0.25 to 0.35
Manganese	0.40 to 0.60	0.40 to 0.60	0.40 to 0.60
Silicon	0.20 to 0.30	0.20 to 0.30	0.20 to 0.30
Aluminum	0.90 to 1.40	0.90 to 1.40	1.00 to 1.50
Chromium	0.90 to 1.40	0.90 to 1.40	.....
Molybdenum	0.15 to 0.25	0.15 to 0.25	0.60 to 1.00

TABLE II

Average Physical Properties of Heat-Treated Nitralloy Grades 125 (H) and 135 (G).

(Test Specimens Machined from 1-In. Bars Heat-Treated as Indicated Below)

Grade	Quenching Temperature in Deg. F.	Tempering Temperature in Deg. F.	Ultimate Strength in Lb. Per Sq. In.	Yield Point in Lb. Per Sq. In.	Elongation, Per Cent in 2 In.	Reduction of Area, Per Cent	Brinell Hardness	Izod
Nitralloy 125	1750	1100	132,000	117,000	18	61	280	62
	1750	1200	122,000	103,000	21	67	255	70
	1750	1300	102,000	85,000	26	70	225	85
Nitralloy 135	1750	1100	155,000	137,500	15	52	310	52
	1750	1200	138,000	120,000	20	58	280	65
	1750	1300	121,000	103,000	23	62	230	80

TABLE III

Analysis and Nitriding Data for Steels Having High Core Hardness

Composition of the Steels

Steel	C	Mn	Ni	Co	Cr	Mo	W	V
A	0.53	0.34	...	...	3.65	0.51	...	0.74
B	1.50	...	...	...	12.11	0.94	...	0.94
C	1.33	0.28	0.55	3.08	13.31	0.81	...	...
D	0.77	0.24	...	...	3.83	8.63	1.35	1.01
E	1.20 to 1.30	...	...	...	1.00 to 1.25	...	4.75 to 5.25	0.15 to 0.25
F	1.04	...	...	...	1.25	1.33	0.51	0.25

Nitriding Results

Steel	Nitriding Temperature in Deg. F.	Nitriding Time in Hr.	Vickers Hardness, 10 Kg. Load	Depth of Case in Inches
A	975	72	975	0.018
B	1000	48	1150	0.012
C	1000	72	970	0.012
D	1000	72	1400	0.015
E	1000	48	925	0.008
F	1000	48	975	0.018

creases, both curves rise, the change in inside diameter increasing more rapidly than the change in the outside diameter. Where the former curve crosses the X-axis, the change in diameter changes from a contraction, due to growth, to an expansion. This is probably accounted for by the fact that, although there is actually growth taking place, it tends to occur along the circumference; and where the wall thickness is sufficient to resist the expansion, actual growth of the wall takes place, decreasing the internal diameter. Where the wall is thin, or not sufficiently thick for the wall material itself to resist the change, actual expansion of the internal circumference takes place, thereby increasing the internal diameter and at the same time causing greater than normal growth of the outside diameter.

Surface Endurance Tests

Surface endurance tests were made by Lieutenants Hubbard and Robinson on a machine designed by Professor Buckingham of the Massachusetts Institute of Technology. The purpose was to determine the relative order of merit of a number of nitrided steels for gears. Fig. 5 shows the specimen or test disk used.

Three views of the testing apparatus are shown in Fig. 6. The parts designated in the figures by letters are as follows: A—Driving motor (electric dynamometer); B—Dynamometer scale (to determine input, if desired); C_1—Adjustable section of frame, rocking on shaft P; C_2—Fixed section of frame, supporting drive shaft; D—Spring for regulating compressive load on test disk; E—Adjusting nut and screw for spring; F—Driven-disk shaft; G—Driving-disk shaft; H—Rollers or test disks; I_1 and L_2—Revolution counters driven from roller shafts; M_1 and M_2—Gears (to reduce slip to a minimum); P—Shaft on which C_1 rocks; and U—Lubricating oil tank.

The surface endurance of the material was measured using rollers or disks under compressive loads. This was found to give results practically identical with those obtained from the Lewis gear testing machine.

The electric dynamometer "A" was used simply as a driving motor; the input to the machine was not desired for these tests.

The pressure between the rollers was adjusted by compressing the calibrated spring (D) by means of the nut and bolt (E), thereby causing that part of the frame (C_1) to move about shaft (P), and forcing the rollers into contact under the desired pressure.

The gears, M_1 and M_2, are not absolutely necessary. A friction drive between the rollers is sufficient if slip is to be tolerated. (As a matter of fact, with the loads encountered here, the slip was small.) However, two 25-tooth, 10-pitch gears were used to eliminate as much slippage as possible. (Note that by use of any other combination of gears that will fit the space, a certain amount of slip of the two rollers may actually be introduced, for example, with 10-pitch gears having 26 and 24 teeth respectively, sliding of the rolls past one another is introduced.) It is believed that with the set-up as used, actual conditions, including the slight slip (due in this case to eccentricities in the rollers) found in gears is approximated.

The runs were stopped at intervals of about 50,000 cycles and the surfaces of the rolls examined. Each time, any surface defects were photographed for comparison with later photographs, thus giving a means of determining when failure actually started. These photographs were made at a magnification of 10 diameters using a specially built camera.

Inasmuch as time was limited, that maximum stress which the surfaces could stand without failure for one million cycles was accepted as the surface endurance limit.

The materials used in the test are given in Table IV.

After heat-treating, the disks were prepared for nitriding. The nitriding was done at 975 deg. F. for 48 hr., after which the disks were tested in the machine previously described.

These tests were made to obtain a relative order of merit of the nitrided steels when considered from the viewpoint of their suitability for gear material. Considering the mechanical features of the test, suitability for use as roller bearings was also determined.

In the design of gears, first consideration is given to the strength of the teeth, i.e., the ability of the tooth, considered as a cantilever beam, to transmit the static and dynamic loads. The next consideration is one of tooth wear. The load should be maintained below that necessary to produce fatigue of the tooth face within the service life of the gear.

Tests were run until the first evidence of surface failure occurred, then continued in order to make certain that the failure was not an "incipient" one but one that would progress in magnitude with additional running. Deter-

TABLE IV

Analysis of Nitriding Steels Tested for Surface Endurance

	Nitralloy 135 (G)	Modified Nitralloy 135 (G)	Nitralloy 135 Containing Nickel	Special Nitralloy L	Nitrard No. 1	Cr-Ni-Mo Steel
Carbon	0.35	0.42	0.27	0.70	1.49	0.37
Chromium	1.20	1.51	1.24	1.70	12.34	0.73
Molybdenum	0.18	0.40	0.25	0.33	0.89	0.33
Aluminum	1.12	1.29	0.92	1.36	...	...
Manganese	0.45	0.51	0.67	0.16	0.30	0.70
Vanadium	...	...	...	0.07	0.89	...
Tungsten	...	...	...	0.26	...	...
Nickel	...	...	3.60	...	...	1.73
Silicon	0.26	0.13	...	0.24	0.25	...
Sulphur	0.017	0.012	0.02	...	...	...
Phosphorus	0.019	0.014	0.02	...	...	...

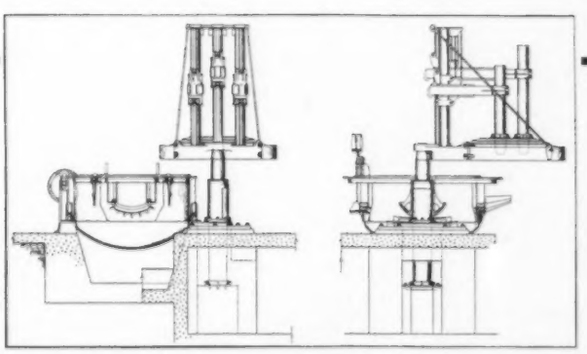
TABLE V

Heights and Energy Values Used for Testing Steels for Impact Resistance

Drop	Height in Feet	Energy Available in Ft-Lb.
Low	0.260	2.44
Medium	0.667	6.25
High	1.073	10.06

Top–Charging a Lectromelt Furnace–Used to Make 12 Ton Heats in 1½ Hours. At the Left–A Duplicate Furnace is Shown Charged Up and in Operation. These furnaces Supply Plain Carbon Steel Which is Poured Into Billet Size Ingots and Rolled on a Merchant Mill with One Heating.

Bulletin TC Describes Lift and Swing-Aside-Roof Quick-Top-Charge Lectromelt Furnaces



User Data Shows the Savings of the Top-Charge Furnace in Power, Man Hours, Electrodes and Refractories

Top Charge Lectromelts are in daily operation on steels varying in grade from those used in the finest tools to steel used for concrete reinforcing bars

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mination of failure was made by visual examination, using a special camera, which permitted examination of the surface of the roll as projected on a ground glass screen at a magnification of ten diameters.

The result of the tests are given in Fig. 7.

It is to be noted that, in general, the steels possessing a high core hardness gave the best results. Although the surface hardness of the chromium-nickel-molybdenum steel (Vickers 650) was inferior to all of the others, it stood up remarkably well in this particular test.

The nickel-containing Nitralloy showed both a high surface hardness (975 Vickers) as well as excellent core hardness, the latter being due to the precipitation of a nickel-aluminum compound during nitriding. This steel offers excellent possibilities for applications indicated by the test.

Drop Impact Tests

The results of the surface endurance test given in Fig. 7 involve line contact. In order to procure data on the resistance of certain nitrided steels to the high stresses involved when point contact is obtained, Sylvester and Whiteside[7] used a drop impact test.

In ball bearings made of unnitrided steels, indentations in the race similar to those made by the Brinell hardness tester may be observed when the bearing has undergone a shock load. If it is assumed that if the time of application of this load is very short, the ball will be stationary with respect to the race. If this is true, it is apparent that a reasonable approximation of the action occurring would be obtained if two pieces of the steel to be tested were placed with a ball between them and a sudden load were applied.

An apparatus to accomplish this result was designed and is shown in Fig. 8. It consists of a base plate with three vertical guide rods. These are secured at the upper ends with a top plate. In the center of the base plate is a recess in which is placed the lower of the two pieces to be tested. A cover plate with a similar recess is made so that it is free to slide up and down on the three vertical guide rods. The upper test specimen is held in this depression, a ball bearing is placed on the lower specimen, and then the cover plate and the upper specimen are lowered until the specimen is in contact with the ball. The weight of the cover plate acts as a minor load and keeps the parts being tested in position. Above the cover plate and sliding on the guide rods is a weight which can be dropped. Attached thereto is a light rod which is used to raise the load. In this rod are cut grooves which can be aligned with a trigger on the top plate so that the weight can be dropped from the same height for each test. The upper side of the cover plate and the lower side of the dropping weight are formed in the shape of truncated cones at their centers so that the load will be applied directly over the test specimens. The amount of the impact can be varied by changing the height of drop or by adding

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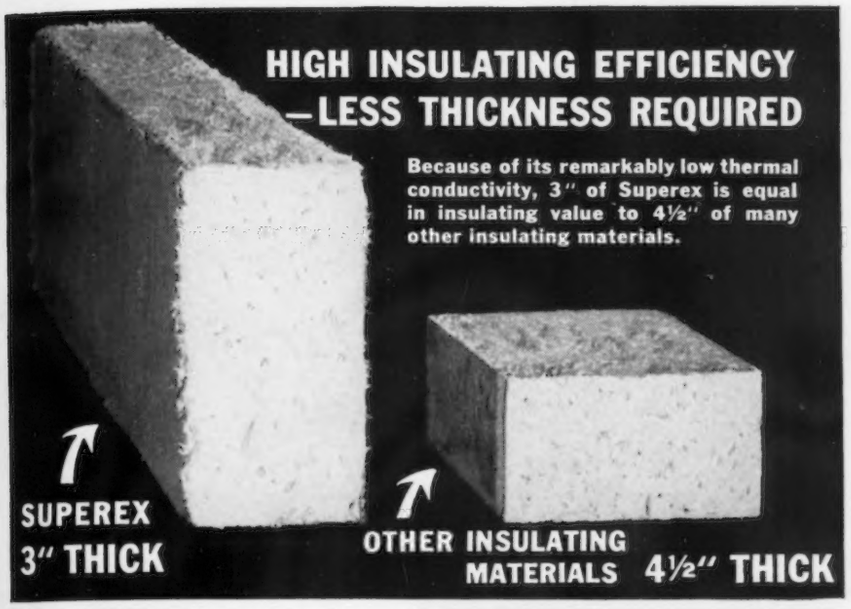
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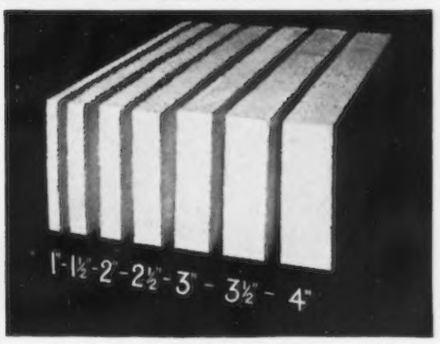

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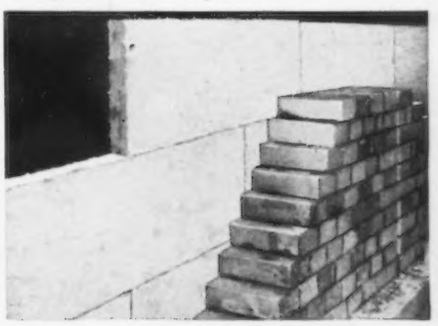

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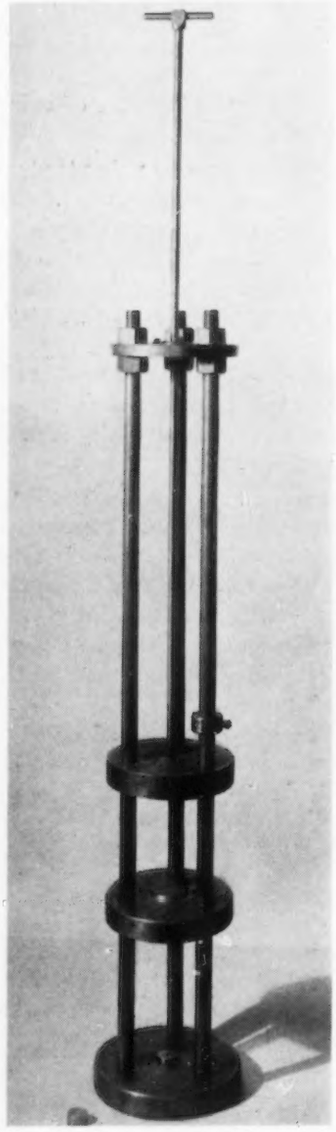
additional weights to the dropping section.

In making the test, the two test pieces and the ball were placed in the manner described and the weight was dropped. The pieces were then removed and examined under a low power binocular microscope in order to see the effect of such an impact load.



AT LEFT

FIG. 8—Apparatus used to determine the drop impact resistance of various nitrided steels. This equipment approximates the behavior of a ball bearing in a race.

o o o

AT RIGHT

FIG. 9—A nitrided ball tested in the machine shown in Fig. 8 will show these types of circumferential and radial cracks when viewed at 25 diameters.

The diameters of the impressions were measured with a Brinell microscope. The amount of energy in the dropping weight is equal to the product of the weight and the distance through which it falls.

The specimens in this test were made in the form of short cylinders ⅞ in. in diameter and ½ in. in length. They were heat-treated and nitrided, after which one of the plane faces was ground on an emery belt so that about 0.0015 in. was removed in each case. This was done in order to expose the hardest part of the case. Three drop tests were used for each steel.

Since it was difficult to determine the exact drop which would produce any given condition at or near the point of contact of the ball and the specimen and since it was found that the ball always broke when high drops were used, in which case the pieces of the ball were driven into the specimen, it was decided to use three standard heights from which to drop the weight. It was believed that the lowest of these would show the effects on the race for shocks which would not be sufficient to break the ball. The medium height was just below that at which balls were broken while the highest was great enough so that the effects of severe impact were apparent. The weight of the cover plate was 7.63 lb. This might be considered as a minor load applied before the shock load. The weight of the dropping parts was 9.38 lb. The various heights used and the energy values in ft-lb. available from these heights are given in Table V.

These loads may seem quite small but it must be considered that the ball bearing used is only 0.125 in. in diameter and that the unit loads are very high. The formula given by Timoshenko[19] for loads in such case is $p_{max.} = 0.62 \sqrt[3]{\frac{PE^2}{d^2}}$, where "$p_{max.}$" is the maximum pressure existing at the outer point of contact in lb. per sq. in. P is the applied load in pounds, E is the modulus of elasticity in lb. per sq. in., and d is the diameter of the ball in inches. From this formula it is found that the stress existing when only the minor load is applied is 471,000 lb. per sq. in., and when both minor load and dropping weight are resting on the specimen, the maximum compressive stress is 610,000 lb. per sq. in. These stresses are very high, but they can be withstood since the steel is in a condition of compression from all sides. These figures show that this method of test is capable of applying very sudden loads of great magnitude to the specimens being tested.

The compositions of the steels that were tested are given in Table III. The partial results of the tests are given in Table VI.

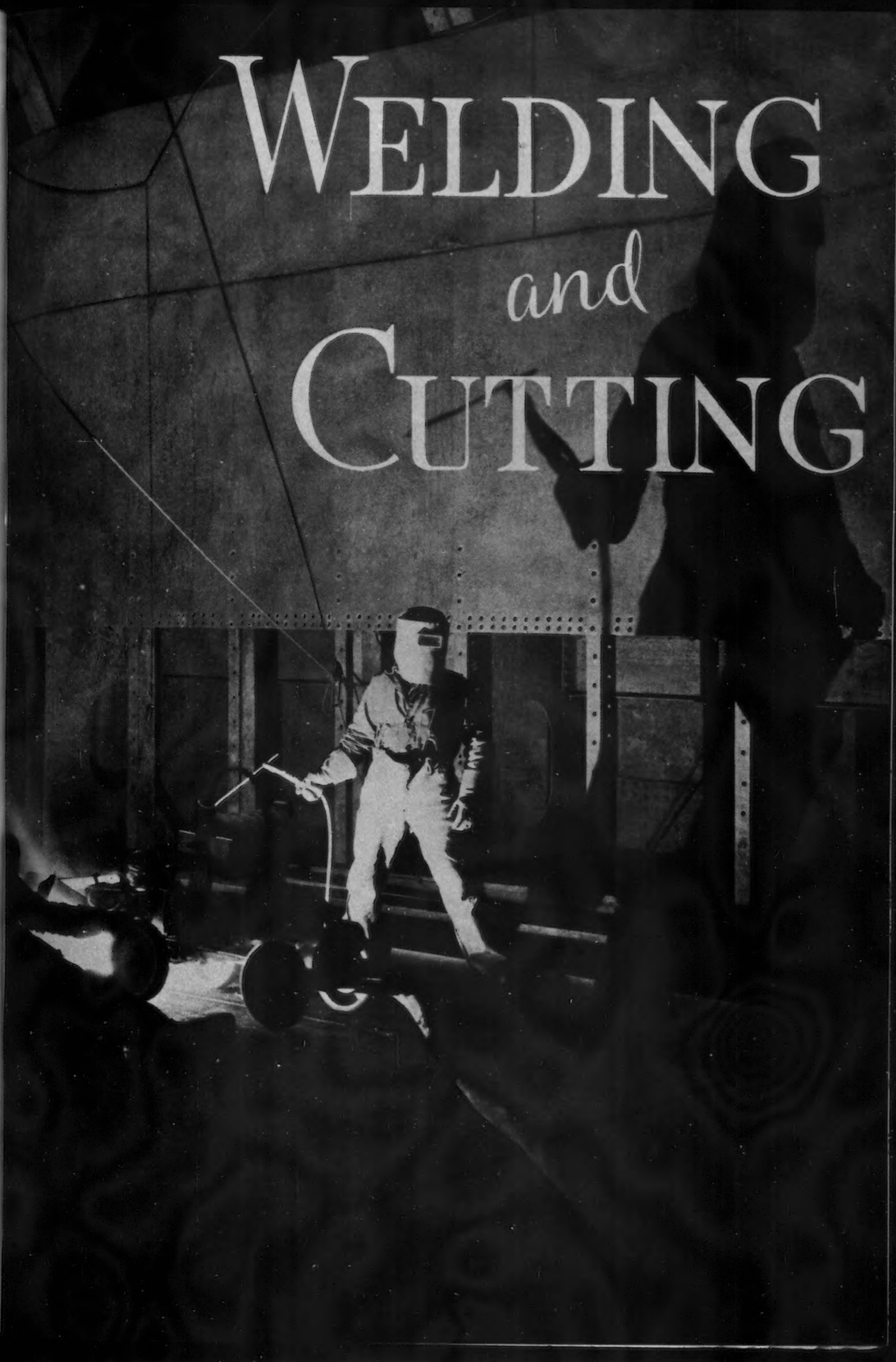
The microscopic examination was made primarily to determine whether or not there was a tendency toward the separation of the case from the core when a severe impact was applied. For the lower drops, there was little evidence of chipping, only a few specimens showing any signs of it. At the high drop, chipping did occur in many cases, but, in some, the breaking of the ball was probably a contributing factor since sharp pieces were forced into the case.

Most of the cracks that formed were of the circumferential type. They usually consisted of one or

(CONCLUDED ON PAGE 98)

[19] S. Timoshenko: "Strength of Materials," Part II; D. Van Nostrand Co., Inc.

WELDING and CUTTING



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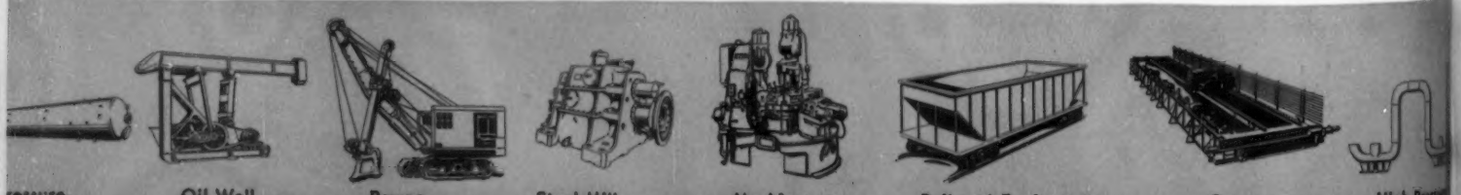

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HEAT EFFECT in WELDING

• part one •

GRATEFUL acknowledgment is made to Prof. Albert Sauveur and Prof. Comfort A. Adams of the Harvard Graduate School of Engineering under whose direction the major portion of this research was conducted and to Col. G. F. Jenks, commanding officer, and W. L. Warner, welding engineer, and others of the technical staff of the Watertown Arsenal for their cooperation.

By Dr. W. G. THEISINGER

Welding and Metallurgical Engineer
Lukens Steel Co., Coatesville, Pa.

THIS is the first of a series of three articles in which Dr. Theisinger outlines the method and conclusions of his own research into the variables which influence the welding of steel, with particular reference to the effect of welding heat on the parent metal adjacent to the weld. Speed of welding and base metal composition were the main variables analyzed. His studies provide a considerable volume of fundamental data of practical interest to both steel producers and welding fabricators.

MUCH valuable information has been obtained and published on the soundness, tensile strength and other properties of the weld metal; so in this study we step, for the most part, beyond the weld and observe the effect of welding on the parent steel member adjacent to the weld. It seems fitting that the steel producer as well as the welding fabricator be familiar with the reaction of the steel base member to the conditions imposed upon it in the welding processes. From the steel maker's point of view, the attack becomes a metallurgical one because of the kind of information sought.

The commercial interest in the problem is centered about the hardening in the metal adjacent to the weld, sometimes resulting in cracks in the parent steel. Regardless of whether or not failure to the point of rupture occurs near the weld, hardening in this region should be kept to a minimum in order to avoid the danger and cost of shop cracks and the inability to absorb impact in service otherwise encountered through an area of unequal physical properties.

Welding makes use of the melting, casting, solidification and subsequent heat treatment of metals in the application of its art to fabrication processes. The electric arc or the oxy-acetylene flame heats the metal surfaces to the molten state and casts this liquid by the movement of the heating instrument. Solidification of the deposited

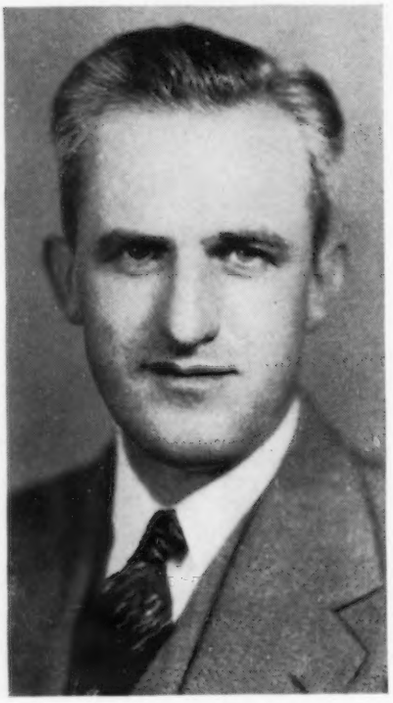
metal results from its loss of heat by radiation into the surrounding atmosphere and by the conduction of its heat into the adjacent base metal. Heat treatment manifests itself in the parent member by virtue of this heating effect created by the fused metal and the heating medium. Even though the procedure employed by welding in transforming a solid metal to the fluid state and back again to solid form in the space of a few seconds or fraction of a second takes place more rapidly than is customary in metallurgical practices, the mechanics of the physical changes are, as a matter of fact, metallurgical in nature.

Changes in Physical Structure the Basis of Present Research

These changes in the physical structure of the metal brought about by welding form the basis of the present research in which microscopic examinations and hardness surveys mainly were employed. Because of the limited area of affected metal available for testing it is apparent why physical testing had to be confined to hardness determinations. Further, because of the small area available for testing, the Vickers-Brinell hardness testing mechine was used in order that readings could be taken at least 0.02 in. apart. Bare metallic arc welding was used for the most part since the equipment at hand for furnishing welded specimens lent itself readily to accurate control of the welding variables.

To assure the highest degree of dependability of results through the elimination of human errors in manipulating equipment, the specimens were welded on an automatic welding machine. This machine uses alternating current for the welding arc with the manual controls operating on direct current. The automatic machine not only provides a means of obtaining consistent welding performance throughout a particular run, but what is more important permits the repetition of a series of experiments on any number of steels where base metal composition, for example, is being introduced as a variable.

Fundamental research requires this control and therefore eliminates hand welding. Manual operation never makes possible constant size of bead and penetration in any one length of weld, let alone comparable duplication from weld to weld. Bare metallic electrode welding rod was used in order to eliminate varieties of flux compositions found in covered rod and the influence such differences would have on the results. This does not mean that such a study cannot be carried out with covered electrodes, but in this work the aim sought for was mainly concerned with the plate metal.



BORN at Carlisle, Pa., in 1904, Dr. Theisinger attended the Harrisburg public schools and in 1925 became assistant chief chemist of the Harrisburg Steel Corp. From 1925-1929 he was associated with the Board of Transportation of the City of New York in the development of welding inspection. He marticulated at Harvard University in 1930 and was graduated four years later with the degree of Bachelor of Science. In the summer of 1934 he served as consulting engineer on high amperage automatic welding at the Western Pipe & Steel Co., San Francisco. In 1935, after further study and specialization in welding metallurgy at Harvard University under Prof. Albert Sauveur and Dr. Comfort A. Adams, he received his degree of Doctor of Science, and soon thereafter joined the Lukens Steel Co. as welding and metallurgical engineer.

Heat Effect Appears As Zone of Varying Shades of Color

The primary object of this research is the studying of the variables which influence the welding of steel with particular emphasis on the effect of the welding heat on the plate metal adjacent to the weld. This heat effect becomes visible on a cross section of the welded specimen after suitable etching of the polished surface. It appears as a zone of varying shades of color grading from black to light gray in the plate material at the rim of that portion of the weld which is in contact with the parent member. The views accompanying this paper illustrate the heat affected zones in steel caused by depositing weld metal on the surface of a plate section.

This gradation in color shade is an indication of changes in microstructure which, in turn, implies a variation in hardness across the affected area. Since the steels used in these experiments are of the alpha iron type and thus harden after quenching, there is always some increase in hardness associated with the affected zones produced by the welding heat. Hardness curves superimposed on the macrographs (4x) of the welded sections in Figs. 1 to 5 inclusive show the variation in hardness between the unaffected plate and the metal adjacent to the weld. As the five macrographs are studied, it may be observed that the hardness values of the affected regions increase with increasing welding speeds. Thus, it is evident that speed of welding is a variable to be taken into account in the welding of plain carbon and alloy steels.

The variables of paramount importance which govern the extent of the heat affected zone in arc welding are:

1—Speed of welding
2—Base metal composition
3—Base metal cross section
4—Welding currents
5—Type of electrode

The same variables would apply to oxy-acetylene welding with the exception that "flame intensity" replaces "welding currents" although its range of flexibility is considerably less.

Variables Confined to Welding Speed and Base Metal Composition

Speed of welding and base metal composition offered the widest range of interesting possibilities from the standpoint of furnishing information of a fundamental nature. Their study should also supply some enlightenment on the prac-

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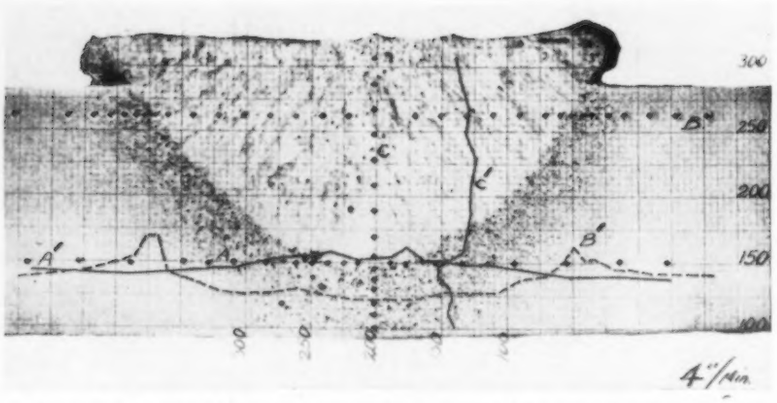


FIG. 1—S.A.E. 1035 (0.33 per cent carbon) 4x. Welding speed 4 in. a minute. Hard zone 162 Vickers-Brinell.

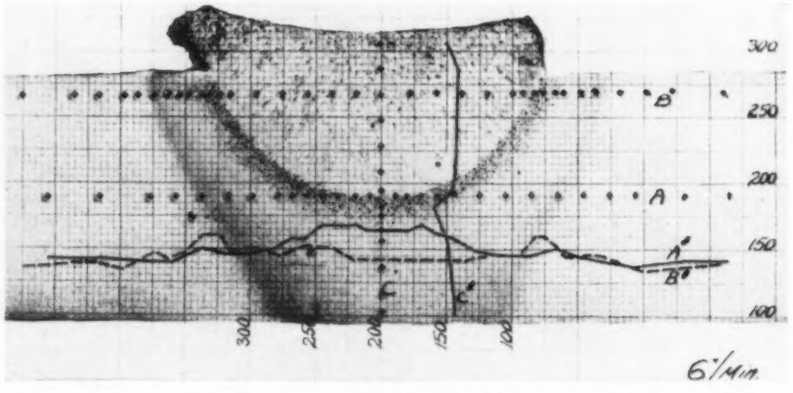


FIG. 2—S.A.E. 1035 (0.33 per cent carbon) 4x. Welding speed 6 in. a minute. Hard zone 168 Vickers-Brinell.

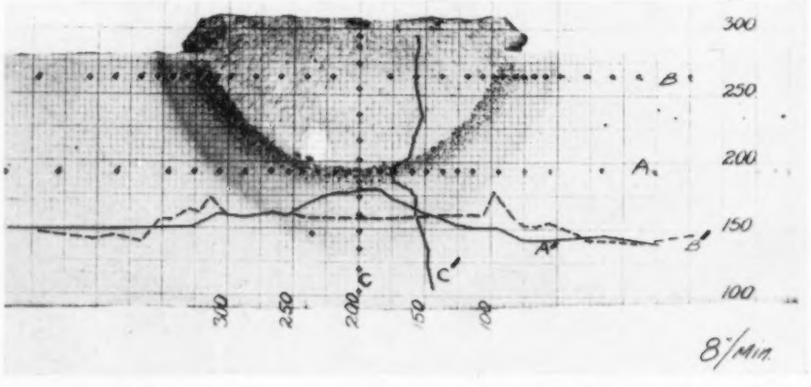


FIG. 3—S.A.E. 1035 (0.33 per cent carbon) 4x. Welding speed 8 in. a minute. Hard zone 177 Vickers-Brinell.

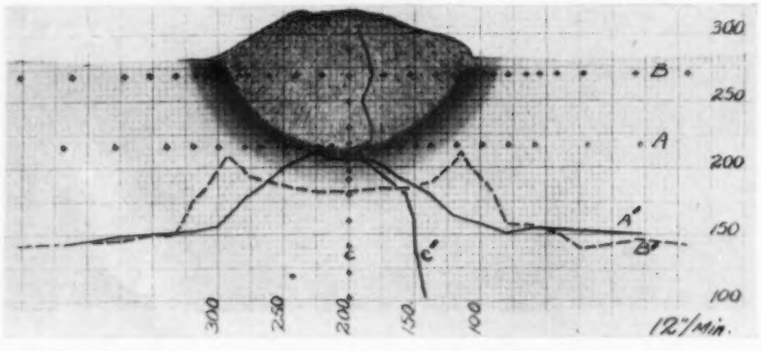


FIG. 4—S.A.E. 1035 (0.33 per cent carbon) 4x. Welding speed 12 in. a minute. Hard zone 212 Vickers-Brinell.

tical problems of structural welding. With the exception of a few experiments in which thickness of base metal was employed as a variable, the variables under analysis were confined to speed of welding and base metal composition. One grade of 5/32-in. bare electrode wire was used throughout.

The actual welding conditions held constant in these experiments were as follows:

Amperage—375 amp.
Voltage—23 volts
Electrode—5/32 in. bare wire
Plate Dimensions—1½ x 2 x 9 in.

The speed of welding was varied in this order, in welding speed in inches per minute:

4 in. 6 in. 8 in. 12 in. 18 in.

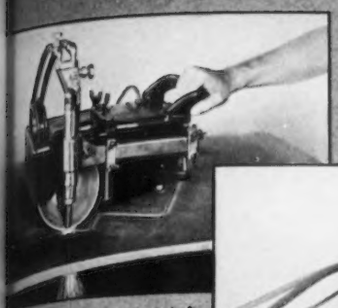
The majority of the steels listed below were subjected to these welding speeds to form a complete series of runs from 4 to 18 in. a minute. Several of the alloy steels were welded only at the intermediate speeds from 6 to 12 in. a minute. The omissions were due to the fact that it was not possible to secure sufficient material of exactly the same chemical composition to run the samples at all speeds and still have enough in reserve for checking purposes.

The plain carbon steels on which the welds were made include the following:

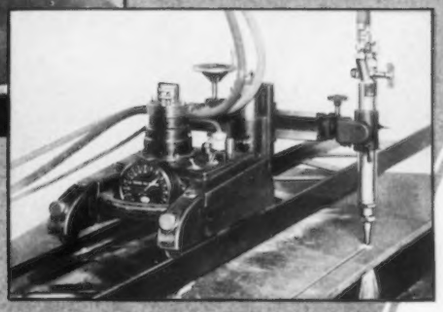
S.A.E. 1015 (0.17 per cent carbon)
S.A.E. 1025 (0.25 per cent carbon)
S.A.E. 1035 (0.33 per cent carbon)
S.A.E. 1045 (0.44 per cent carbon)
S.A.E. 1050 (0.53 per cent carbon)

The strip stock when welded was in the as-rolled condition and was not machined in any way prior to welding. The welded specimens were prepared by depositing the "weld." or in more exact terms, a "bead," on the top surface of the ½-in. thick plate, in the middle of the 2 in. width for the entire length of the sample which was 9 in. This method of making the weld was adopted for two reasons: First, to obtain the heat effect which the steel under the conditions imposed was capable of producing; and second, to prevent the introduction of undesirable variables such as attend the machining and fitting of beveled edges.

Each strip rested on a cold steel plate, ¾ x 4 x 12 in., and both were fastened rigidly to the platen of the welding machine by means of steel clamps. Prior to this, preliminary runs were made in order



ACTOGRAPH



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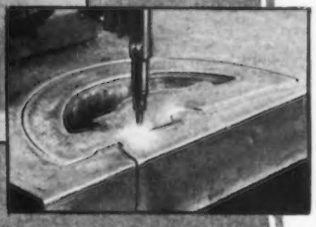

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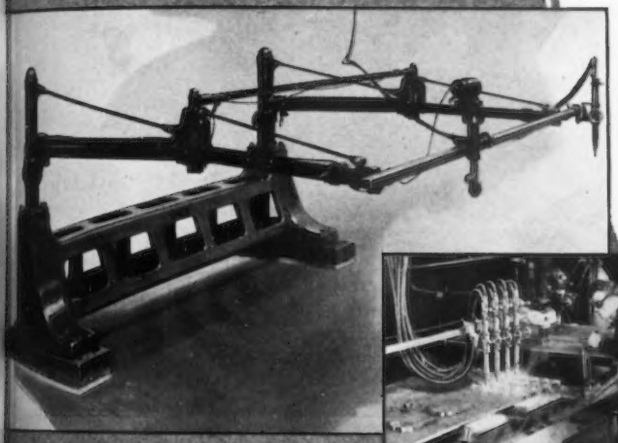
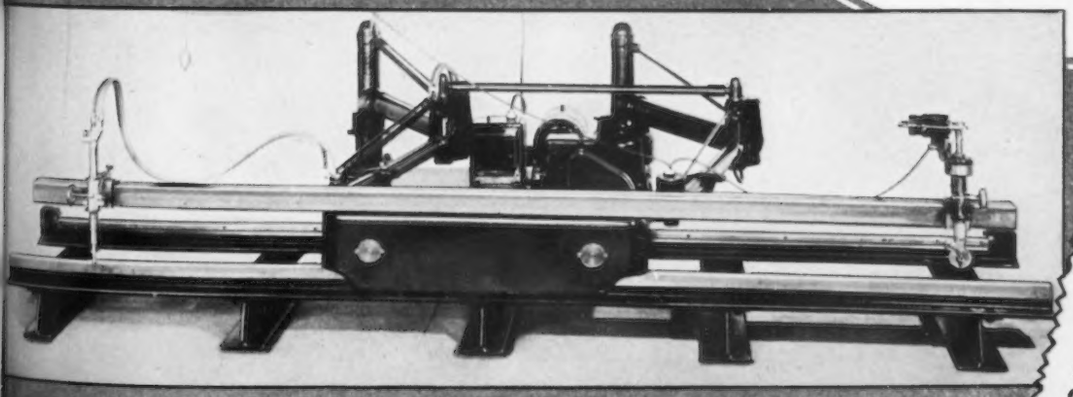


OXYGRAPH



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to adjust the wire feeding mechanism which is important in securing uninterrupted arc operation. The weld was completed at the predetermined welding speed, the clamps removed and the specimens allowed to cool to room temperature lying weld up on the concrete floor of the laboratory. This procedure was followed after every run more for uniformity of cooling than for any influence such practice would have on the specimen. It merely served as another precaution taken to balance all factors so that the comparison of the correlated data would not be hampered by outside sources of unknown proportions.

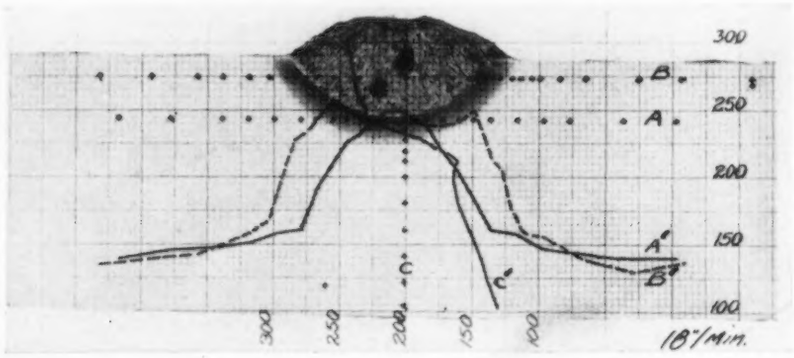

FIG. 5—S.A.E. 1035 (0.33 per cent carbon) 4x. Welding speed 18 in. a minute. Hard zone 250 Vickers-Brinell.

Specimens X-Rayed

The welded specimens were x-rayed to disclose their response to combinations of welding variables and to aid in selecting the test specimen for examination. Gas pockets, void of metal, detract from the full effect of the weld on the base metal and therefore interject errors into the findings. Although a rule was established that the test section was to be taken within a space not less than 2 in. nor more than 3 in. away from the center of the crater, this area would not be representative of the weld if it were the only solid or porous region in any otherwise porous or solid specimen.

Again, in order to maintain a strict relationship from weld to weld, the position of the test coupon in the welded specimen had to be defined due to the fact that the heat affected zone varies somewhat in structure and hardness from the beginning to the end of a run. It is evident that there must be some difference when one considers that the weld is started on a cold plate, whereas the crater at the finish is deposited in metal that has been slightly preheated. Preheating caused by the heat traveling ahead of the arc offers less resistance to the melting of the plate and consequently the bead increases in area so that there is more heat energy absorbed per inch of plate. As the quantity of available heat energy per unit length of bead increases, there is a corresponding decrease in the hardness of the affected zone. Fortunately, this condition soon reaches a state of equilibrium, in fact the penetration of weld metal in the last 4 in. of the 9-in. bead has assumed a uniform depth.

Two Variables Reduced to Single Factor

The question of heat energy brings to light a means of reducing two variables, welding speed and current, to a single factor. Figs. 1 to 5 inclusive illustrate the effect of increasing the speed of welding while holding the amperage and voltage constant. The size of bead decreases and the hardness of the affected zone increases as the welding speed is augmented from 4 in. to 18 in. a minute. Approximately the same variation in hardness and cross-section of bead could be obtained if the speed of welding were held constant and the amperage reduced through a definite range. The relationship between amperage, voltage and welding speed in inches a minute may be expressed as:

$$\frac{\text{Amperes} \times \text{volts} \times 60}{\text{welding speed in./min.}} = \text{Joules/in.}$$

In general, as long as these variables are balanced, either by higher amperage and higher speed or lower amperage and lower speed, the heat energy expressed in Joules/inch will remain constant and the effect on the welded member will be approximately the same.

For example, the following welding conditions produce the same heat energy value and likewise affect the plate metal to practically the same extent:

Amperage	400	200
Voltage	20	20
Welding Speed	16	8
Joules/inch	30,000	30,000

In place of the figures used in the foregoing where the variations in welding speed were reported, the heat energy values would prove equally satisfactory. These values are given below with the corresponding welding speed in inches a minute.

All welds made in this study were deposited with 375 amp. and 23 volts.

4 In.	6 In.	8 In.	12 In.	18 In.
129,400	86,250	64,700	43,100	28,750

In fact, the heat energy figures present a greater amount of information since any desired effect may be produced through a moderate range of variables as long as the heat energy value for that particular condition is duplicated.

It is worthy of note, in summary, that the hardness of the heat-affected zone increases as the number of Joules per inch is decreased.

Formation of the Heat Affected Zone

The heat affected zone found in welded steel sections is due to the property possessed by iron, containing a sufficient amount of carbon, of becoming extremely hard when rapidly cooled from a high temperature, as for instance, by quenching in water from a bright red heat. This operation is known as the hardening of steel as defined by Prof. Albert Sauveur in "The Metallography and Heat Treatment of Iron and Steel." In order to harden steel, it is necessary first to heat it above its critical range because it is in passing through that range that it acquires hardening power. Sudden cooling from a temperature inferior to its critical range would result in but a very slight, if any, increase in hardness.

The requirements for hardening the parent steel plate in the heat affected zone adjacent to a weld

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are satisfied in every detail. The steels studied in this investigation contain not less than 0.15 per cent carbon so that rapid quenching would produce a measurable increase in hardness. Rapid quenching is brought about by the mass action of the parent metal in conducting the heat rapidly away from the vicinity of the weld. Temperatures far exceeding the critical range are reached in melting the metal, but the heat gradient is steep from the fused area to that portion of the plate which remains below the critical range. For this reason the heat affected or hardened zone is usually limited to fractions of an inch in depth.

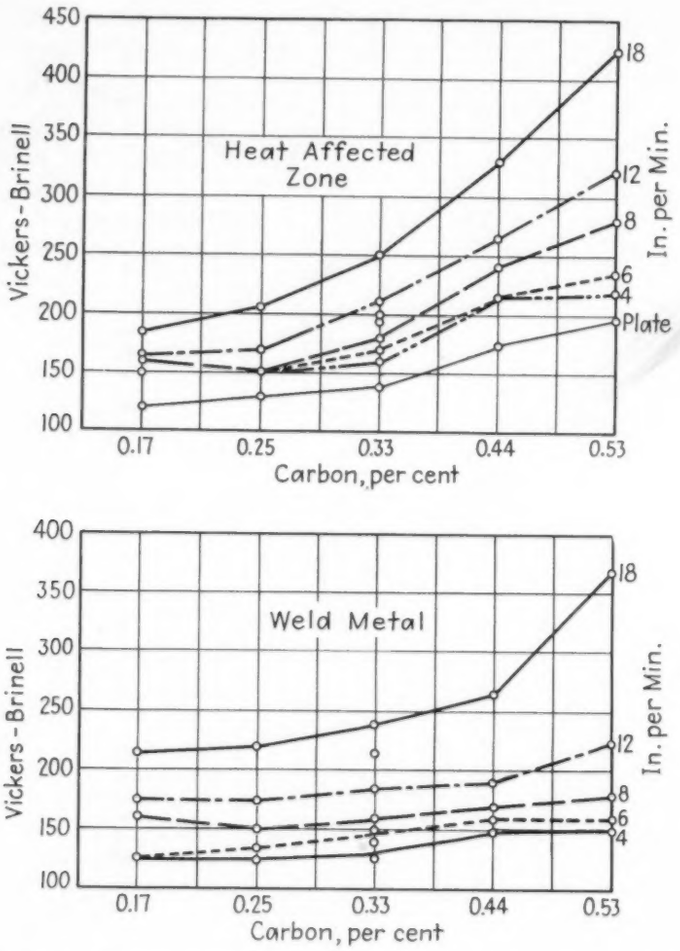


FIG. 6—Summary of hardness values on five plain carbon steels welded at varying speeds. The unaffected plate is shown for comparison.

Necessary to Reduce Zone of Unequal Hardness

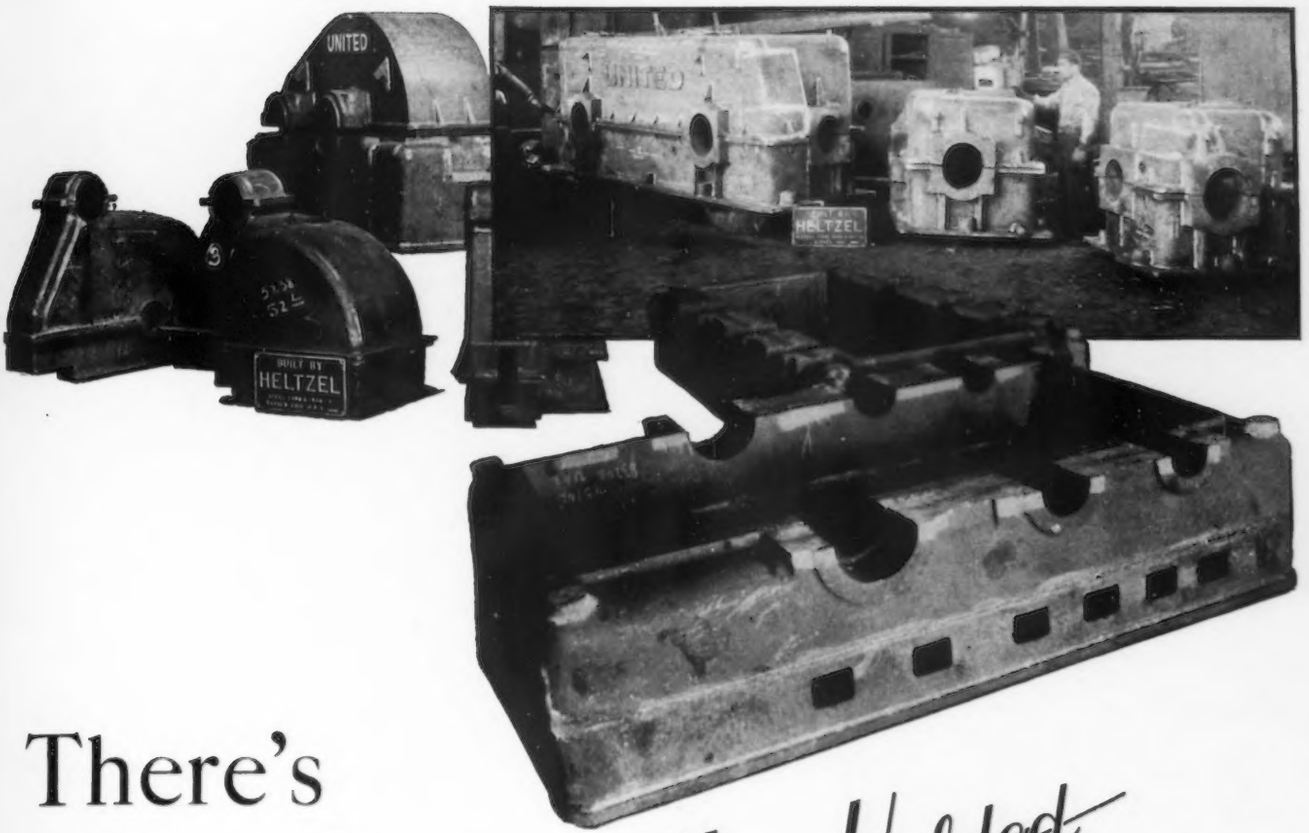
Thus the heat affected zone is a reality and the terms for its formation are inherent in any process which produces a weld. Its depth and hardness depend upon variables which are not at all mysterious, at least not in their qualitative effect on a steel specimen. The combining of these variables should become a perfectly rational balancing of one with another and with the whole. There should be no doubt existing regarding the necessity for eliminating or at least reducing this zone of unequal hardness which not only disrupts the continuity of the physical properties of the parent material, but when excessive, by the nature of its reaction under service stresses, may cause failure of the member near or in this heat affected zone. This study sought to correlate the functions of each variable responsible for producing this heat affected zone in the parent metal adjacent to the weld.

Figs. 1 to 5 inclusive show the polished and etched cross sections of one series of welds, magnified four times, with the Vickers-Brinell hardness curves superimposed on the macrographs. One grade of steel, SAE 1035, carbon content 0.33 per cent was welded on an alternating current automatic welding machine by depositing a bead with bare 5/32-in. wire on the surface of the ½ x 2 x 9 in. plates using 375 amp. and 23 volts at welding speeds of 4, 6, 8, 12 and 18 in. a minute.

Three Lines of Hardness Indentations on Each Specimen

Three lines of Vickers-Brinell hardness indentations were run on each specimen and may be seen on Fig. 3, for example, as a series of black diamond shaped marks, on the horizontal line *A* tangent with the base of the weld. The horizontal line *B* passes through the weld and plate about 0.10 in. below the top surface of the plate, and the vertical line of indentations takes in both weld and base metal. All three lines pass through the hardened zones. The readings of the Vickers-Brinell impressions were plotted on graph paper and photographed to exact scale on the macrographs. The horizontal solid line *A* indicates the hardness of line *A* of impressions, the broken line *B* shows the hardness of line *B* near the top of the specimen, and the vertical line *C* follows line *C* through the middle of the weld and heat zones. The extremes of the lines reveal the hardness of the unaffected base metal although this actual determination was made near the sides of the specimen, beyond the above views. The Vickers-Brinell values for line *A* and *B* are given at the right of the illustrations, while line *C* may be read from the bottom row of figures.

The heat affected zone extends from the edge of the weld into the plate material and appears as varying shades of color resulting from etching, the etchant being 1.0 per cent Nital. Just adjacent to the weld the black zone was heated, we might safely assume, almost to the melting point and the farthest rim of the affected zone was heated just about the Ac_1 point. Accepting this fact from examination to be described later, the heat gradient from 1530 deg. C to 700 deg. C takes place over ¼-in. on the actual specimen. The hardest portion of the affected zone is in the plate immediately adjacent to the bead at the point where increasing hardness



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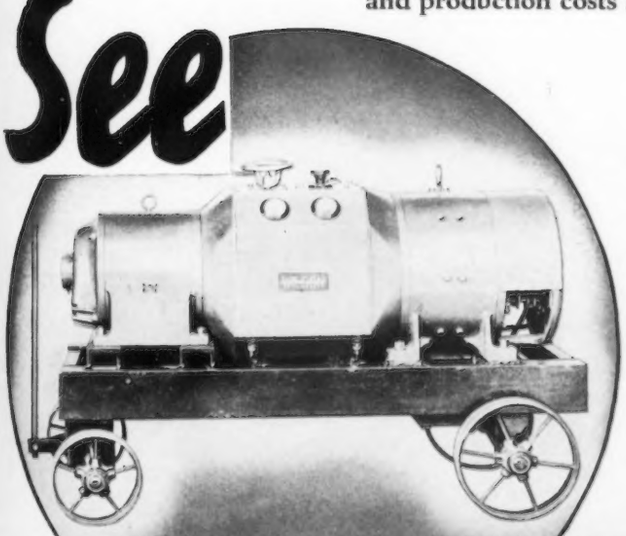

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follows quenching from increasing temperatures (Tmax.).

With this method of showing hardness, the value for any point tested is found by reading the corresponding point on the curve representing that particular line. For example in Fig. 3, the greatest hardness 179 Vickers-Brinell appears on line *A* at the base of the weld; thus, the two impressions on line *A* just to the right of the vertical line *C* indicate the location of this hardest area. To the left the hardness is 177. All impressions in the hardened zone are 0.02 in. apart; elsewhere they vary from 0.05 to 0.10 in. between points. These values can be checked by referring to line *C* where its hardest points lie along and just below line *A*; the greatest hardness along this line being 176 Vickers-Brinell. Again the maximum hardness of the specimen is checked along line *B* at each side of the weld where the peaks show 177 at the right and 173 at the left of the weld. This method yields five points for finding the area of maximum hardness, the average of the above being 176 Vickers-Brinell for the greatest hardness of this specimen.

Increased Hardness from Increased Speed

Following through Figs. 1 to 5, the effect of increasing welding speeds or decreased heat energy input causes increased hardness in the metal adjacent to the weld. The greatest hardness in Fig. 1 is 168, whereas, in Fig. 5, we find 250 Vickers-Brinell. Since this variation of hardness values appears in the same steel, it is evident why some consideration should be given commercially to the heat energy input used in welding.

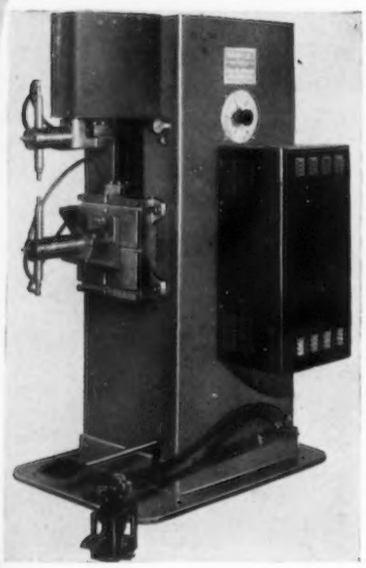
It is possible, as will be described later, to maintain a more even balance between the hardness of weld metal, affected zone and plate metal of many of the common plain and alloy steels in use today.

Since the publication to follow in this series of three articles treats the heat effect of welding in plain carbon steels, Fig. 6 is included at this time to show the effect of carbon in steel as the variable of greatest importance. A curve is drawn for each welding speed through the several carbon ranges from 0.17 to 0.53 per cent carbon. The Vickers-Brinell hardness values appear at the left.

The effect of increased welding speed in inches a minute is thus shown for any carbon content. Furthermore the hardening power of carbon after quick cooling is at once apparent. The deviation from the unaffected parent plate hardness values becomes greater as the carbon content and the cooling rate are increased.

One fact is significant: Beyond 0.33 per cent carbon, the hardness of the heat affected zone mounts rapidly. Up to this point, the rise in hardness is gradual.

As will be discussed later, as the carbon content of the plate metal is increased, the speed of welding should be reduced or the amperage increased or some preheating used. In other words, for increases in carbon, increase the heat energy input per unit of weld.



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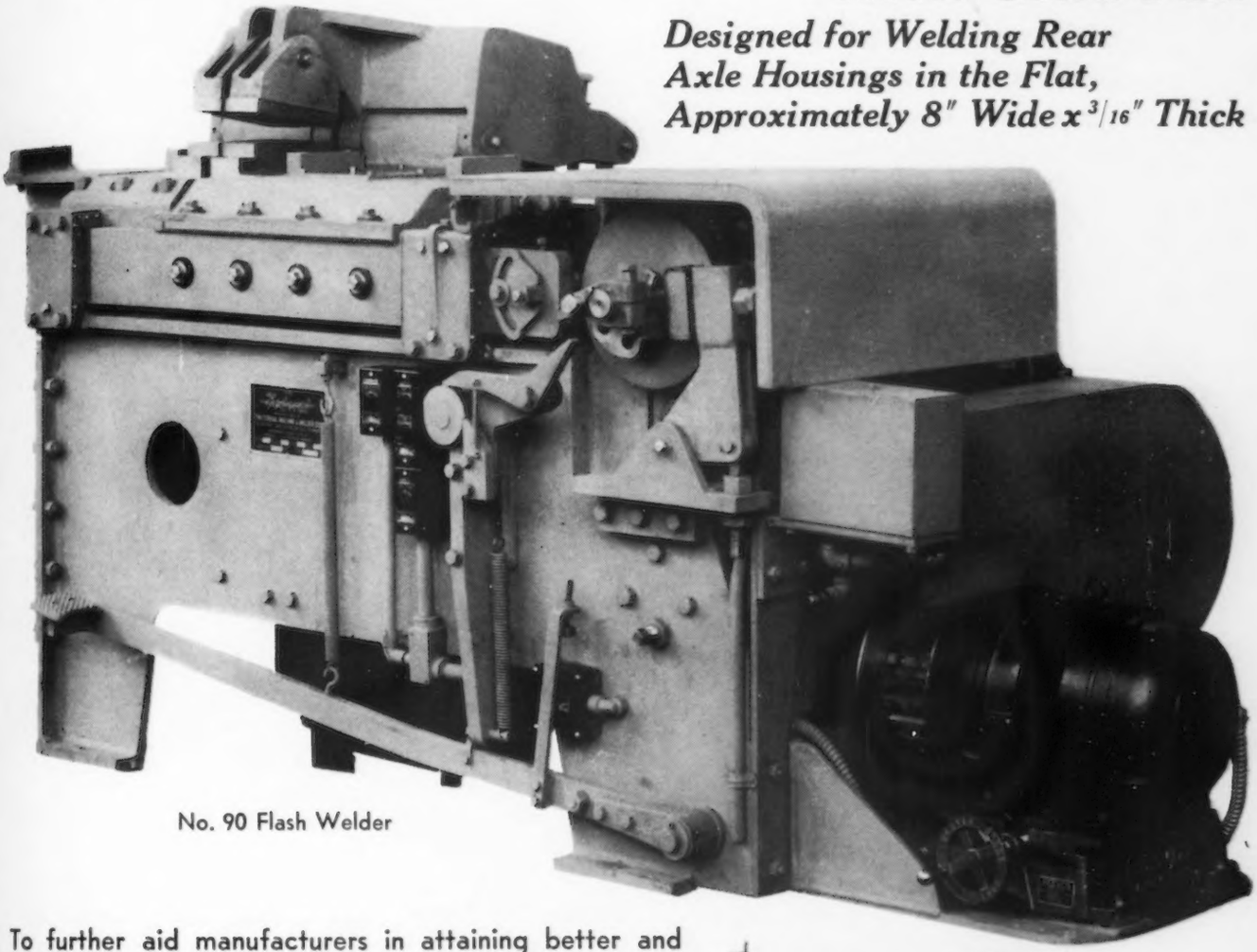

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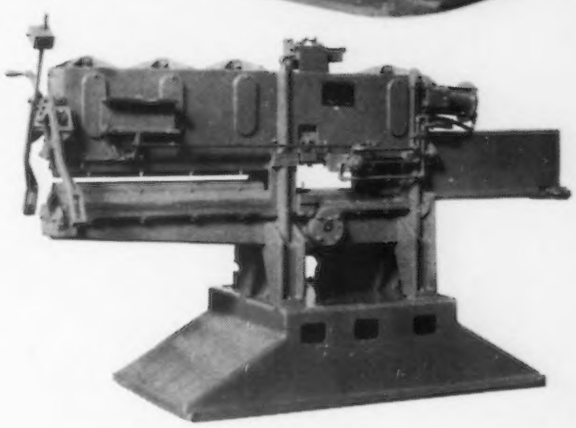

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NITRITING

(CONCLUDED FROM PAGE 66)

more rings around the outside of the depression. In all probability they formed first. As the load strikes, the ball carries with it into the metal successive rings of the specimen, if the case is very hard. If the case is relatively ductile, no rings will be seen since the metal will yield easily. It is believed that the radial cracks are caused by the plastic flow of the core which pushes up the case in the region outside of the hole. This phenomenon was noted especially in some of the high drop tests where the metal was visibly pushed upward. Fig. 9 at 25 diameters shows both circumferential and radial cracks.

Steel D almost always showed circumferential cracks but gave the least number of radial cracks, indicating that very little flow of the core took place. Chipping was also relatively infrequent with this steel.

Steels A, B and C showed a greater tendency toward cracking of both types and chipping than did any of the others. Steels E and F showed less tendency toward cracking than did the others. They showed a greater tendency toward radial than toward circumferential cracking. The case appeared to be comparatively ductile. In many of the low drops no cracks could be detected.

The results of all of the tests indicated that steel D was superior to the others where a combination of a hard case with a high core hardness was involved together with satisfactory impact resistance.

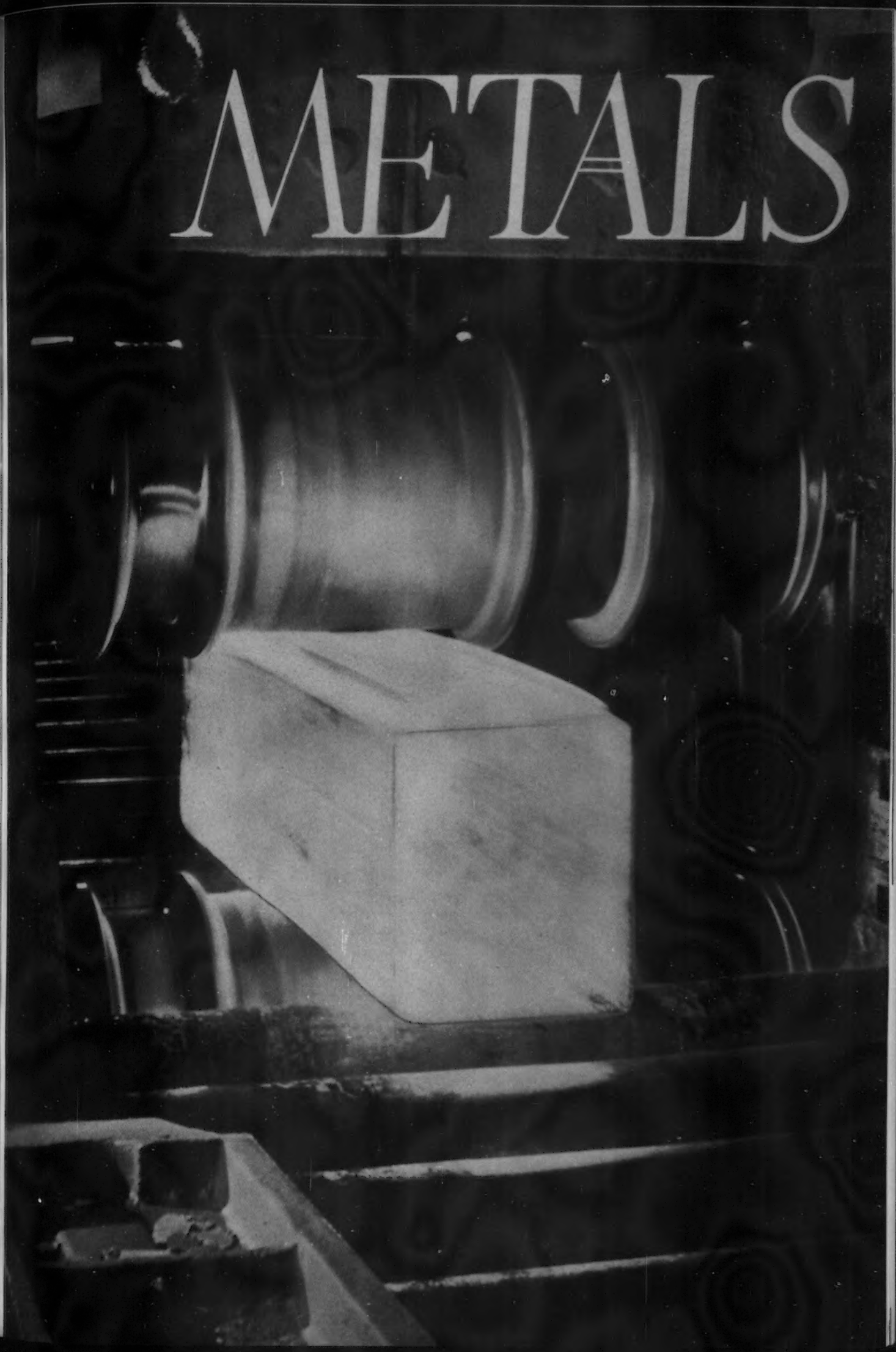
TABLE VI

Drop Impact Tests on Various Nitrided Steels

Steel	Type of Drop	Nitrided at 975 Deg. F. for 48 Hr.		Nitrided at 1000 Deg. F. for 48 Hr.		Nitrided at 1000 Deg. F for 72 Hr.	
		Impression, Diameter in Millimeters	State of Metal Around Impression	Impression, Diameter in Millimeters	State of Metal Around Impression	Impression, Diameter in Millimeters	State of Metal Around Impression
A	Low	1.40	b	....	....	....	....
	Med.	1.65	a,b	....	....	....	....
	High	1.80	a,b,c	....	....	....	....
B	Low	....	....	1.20	b	....	....
	Med.	....	....	1.50d	a,b	....	....
	High	....	....	1.55d	a,b,c	....	....
C	Low	....	....	....	....	1.50	a,b
	Med.	....	....	....	....	1.75	a,b
	High	....	....	....	....	2.00	a,b,c
D	Low	....	....	....	....	1.00d	b
	Med.	....	....	....	....	1.45d	b
	High	....	....	....	....	1.55d	b,c
E	Low	....	....	1.35	....	....	....
	Med.	....	....	1.60	a	....	....
	High	....	....	1.85d	a,b	....	....
F	Low	....	....	1.35	....	....	....
	Med.	....	....	1.80	a	....	....
	High	....	....	2.00	a,b	....	....

a = radial cracks
b = circumferential cracks
c = chipping of case
d = ball broke in test

METALS



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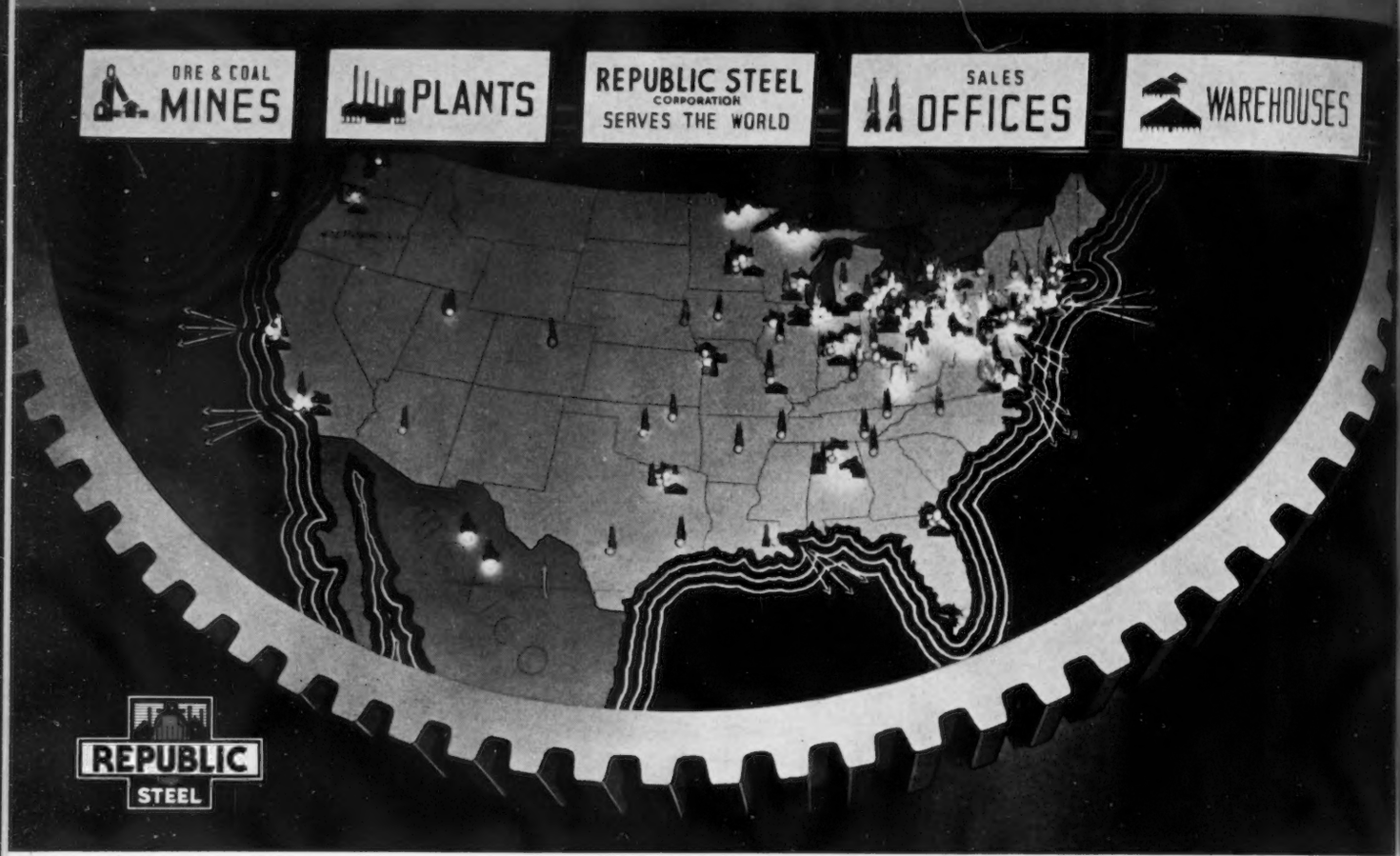

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SPRINGS of STAINLESS STEEL

◇ ◇ ◇

By SAM TOUR

Vice-President, Lucius Pitkin, Inc.

◇ ◇ ◇

MANY springs must be resistant to corrosive gases or liquids. However, existing literature contains little on the application of stainless steels for springs. This report, therefore, is timely and should be of considerable immediate value to many equipment makers. For the author proves, among other things, that if a Rockwell hardness of C-39 is adequate, a properly heat-treated stainless iron performs as a spring even better than chrome-vanadium spring steel. The data presented are fully supported by the performance records of thousands of springs in actual service.

◇ ◇ ◇

BY general acceptance stainless steels have been roughly divided into three classes. The so-called martensitic stainless steels constitute one class, the ferritic steels make up a second class and the austenitic steels are grouped into a third class.

The first group, martensitic steels, might well be further subdivided into three classes, namely, low carbon, intermediate carbon and high carbon. Limits for these sub-classes might be set up in the following manner: the low-carbon or first class being those chromium-containing stainless steels of carbon content not over 0.12 per cent maximum and chromium in the range from 12 per cent to 14 per cent; second sub-class being those hardenable chromium carbon steels with carbon content between 0.15 and 0.45 per cent and chromium from 12 per cent to 14 per cent; and third, or high-carbon sub-class, being defined as those chromium carbon steels containing from 0.50 to 1.10 per cent carbon and chromium from 14 per cent to 18 per cent.

The first sub-class, or the low-carbon variety, is sometimes referred to as stainless iron, rather than stainless steel. The second class, or the medium-carbon variety, is generally referred to as cutlery stainless steel, and the third class, or high-carbon variety, is sometimes referred to as a modified cutlery stainless steel.

Cutlery steels of the intermediate carbon class formed the basis of the original Brearly patent, al-

though this patent permitted the carbon content up to 0.70 per cent with chromium between 9 and 16 per cent. The standard composition adopted for cutlery in the early days of the Brearly patent contained 0.30 to 0.40 per cent carbon and 13 to 14 per cent chromium. A very considerable amount of experience throughout the world in the application of this intermediate-carbon chromium stainless steel for cutlery purposes has led to certain generally recognized applications and procedures for heat treating for each particular application.

A survey of the recommended heat treating practices for many applications yields considerable information regarding quenching temperatures and tempering temperatures. For instance, recommended hardening temperatures range generally between 1775 deg. and 1850 deg. F., and tempering temperatures between 350 deg. and 900 deg. F. The literature shows some study of the relationship between tempering temperatures and brittleness, but seems to be somewhat lacking in information regarding the effect of time either at quenching temperatures or at tempering temperatures.

With respect to the possible application of the intermediate-carbon variety of cutlery stainless steels to springs, there is little information. E. E. Thum in an editorial note in the second edition of "The Book of Stainless Steels," page 287, refers to a study made of the torsional modulus of elasticity of various materials suitable for springs at high temperatures or in corrosive atmospheres. In this particular study a stainless steel of 14 per cent chromium and 0.38 per cent carbon was tested, once as oil quenched from 1825 deg. drawn at 900 deg., and, also, tested as oil quenched from 1650 deg. and drawn at 900 deg. At room temperatures a torsional modulus of elasticity of 11,730,000 lb per sq. in. was found.

N. L. Mochel, in chapter 10 of "The Book of Stainless Steels," on page 263, states "one of the leading spring manufacturers recommends an alloy with 13 per cent chromium, 2 per cent nickel and 0.12 per cent maximum carbon for springs which must resist corrosion. While this alloy can be drawn into wire, the recommendation is that it should be cold rolled or drawn from annealed bars or strips to various degrees of hardness depending upon requirements up to 220,000 lb. per sq. in maximum ultimate strength."

TABLE I

Heat Treatment of Stainless Steel Specimens

Specimen No.	Hardening Time in Min.	Hardening Temperature Deg. F.	Average Impact Strength	Average Hardness, Rockwell C
1	30	1700		42.3
3	30	1700	3.91	42.8
5	60	1700		45.2
7	60	1700	3.95	46.0
9	30	1725		45.8
11	30	1725	3.55	45.3
13	60	1725		46.7
15	60	1725	3.58	45.5
17	30	1750		46.0
19	30	1750	3.50	45.0
21	30	1775		46.6
23	30	1775	3.30	46.5
25	15	1800		46.8
27	15	1800	3.30	46.7
29	30	1800		50.01
31	30	1800	2.62	49.0
33	60	1800		49.0
35	60	1800	2.71	50.0
37	15	1825		50.0
39	15	1825	2.92	48.0
41	30	1825		50.7
43	30	1825	2.64	50.0
45	15	1850		51.5
47	15	1850	2.20	50.8

One may ask the question, "why are cutlery stainless steels not more generally used for spring purposes?" The writer asked this question some years ago, and, being unable to find a satisfactory answer as to why not, decided to carry out a series of experiments in connection with one specific application.

Application for Springs

In the specific application in mind, it had been the practice for some time to use a carbon or a chrome-vanadium spring steel subsequently plated with copper, nickel and chromium for protection against rusting. It was hoped that this spring could be made of stainless steel, thereby eliminating the plating and finishing operations and the difficulties due to rusting of plated steel articles when exposed simultaneously to corroding conditions and a service liable to cause scratching or perforation of the plate. The springs in question were made from steel bar stock approximately ½ in. in diameter. Each spring in service was approximately 15 in. long and was subject both to flexure and torsion stresses, rather suddenly and repeatedly applied. Each end of the spring carried a threaded nut attachment.

Stainless steel of the cutlery type is primarily stainless only in the hardened condition. It should be tough when hardened and drawn at temperatures up to around 600 deg. F., and is liable to be brittle if drawn at temperatures somewhat above 600 deg. but below 900 deg. F., and is again apparently fairly tough when drawn at temperatures above 900 deg. or 950 deg. The difficulty with the material after drawing at these high temperatures is that it tends to soften quite rapidly at the higher temperatures and, as it softens, it loses its stainless qualities. This dos not mean that it becomes entirely non-rust-resisting, but simply is not quite as rust-resisting as it would be if it were left full hard. The writer often questions just how much of this stainless property is absolutely necessary and how much of it can be sacrificed in return for additional fatigue-resistance. The various heating and forming and other operations should be so arranged that when a spring is fractured a good silky non-crystalline fracture is obtained.

In order to obtain full fatigue-resistance from springs, it must be realized that all traces of surface decarburization, soft skin, scale, small surface cracks, etc., must be removed by grinding and polishing operations. This applies not only to fatigue-resistance, but also to stainless properties, as stainless steel of this type must be

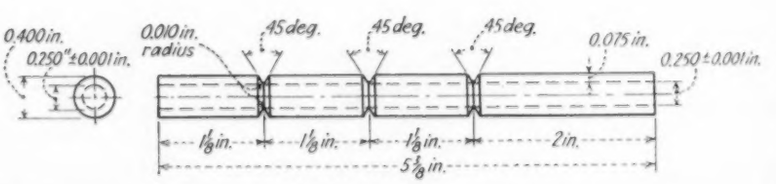

FIG. 1.—This modified round Izod impact test specimen was used to determine the toughness of stainless steel. For machining this bar, a general dimensional tolerance of 0.010 in. is permissible with a tolerance of 0.001 in. on 0.25 in.; there is a fine finish all over and small centers on the ends are permissible.

polished and free from scale if it is to be non-rusting.

An intermediate-carbon cutlery stainless steel was supplied for the purpose by one of the steel companies and a certain heat treatment was recommended. One lot of springs was made and heat treated by air hardening from 1725 deg. and drawing at about 600 deg. to a final Rockwell hardness of about 40. (The practice on chrome vanadium and carbon steel springs had been to heat treat to a Rockwell hardness of approximately 36 to 40.)

A large percentage of this first lot of springs failed in service. The broken springs were studied from the standpoint of fracture and hardness. The fractures varied from slightly fibrous to coarse crystalline. None of the fractures showed a fine silky structure such as was expected to result from the recommended heat treatments. In general the appearance of the fractures indicated that somewhere during the various operations in the manufacture of the spring or in the manufacture of the original stock, the steel had been considerably overheated and caused to develop a fairly large grain size.

An additional lot of springs was made up and heat treated by oil quenching from 1800 deg. F., and drawing at about 600 deg. F. to a final Rockwell hardness of about 48. A large percentage of this lot of springs failed in service and all showed somewhat crystalline fractures.

It became quite evident that more information was necessary regarding proper heat treatments for this type of steel to obtain maximum toughness.

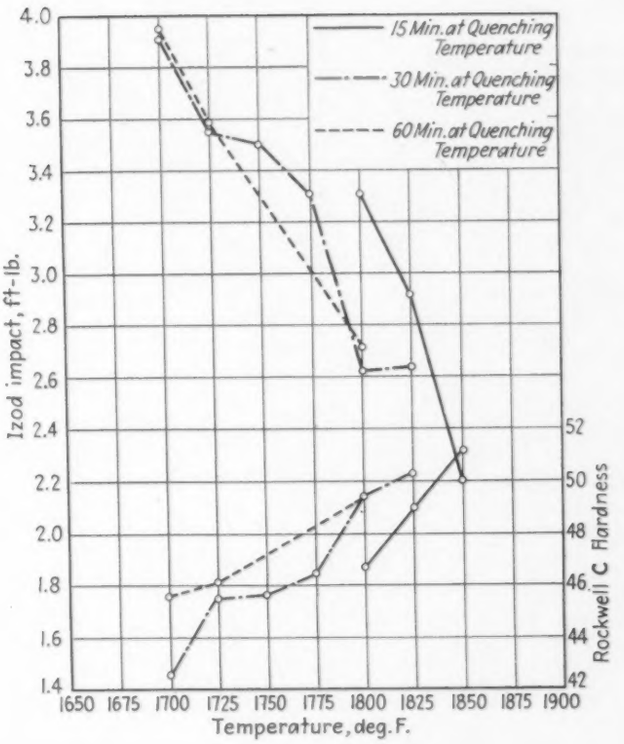

FIG. 2—Izod impact strengths and Rockwell hardnesses for stainless steel quenched in oil. The data plotted here are shown in Table I.

Types of Tests

Toughness can be tested for in a number of different ways. The interpretation of the results of laboratory tests in terms of service is, however, a very difficult thing. For springs one might choose any of the many different types of fatigue tests which are being used today, but these are in general very time-consuming and, also, very expensive. One might choose the (verdampfung) "damping" test developed in Europe, but only one or two of the machines are in this country and the details of the technique of testing have not as yet been fully worked out. The single blow impact type of testing seemed, therefore, to offer the most promise.

Single blow impact tests can be carried out on notched or untouched test bars. The fact that a sizable percentage of the spring failures came from breakage of the threaded ends indicated that the effect of sharp corners, notches, etc., was of importance. The notched type of impact testing was thus indicated.

Impact tearing (or tension testing) was not considered. Transverse impact testing can be carried out on cantilever (Izod) or simple beam (Charpy) type specimens. In the first case (Izod), the specimen is held firmly in jaws or a chuck at one end and the unsupported or protruding end is struck transversely and the energy absorbed in causing fracture in one blow is measured. In the second case (Charpy), the specimen is laid against two supports near its ends and the center is struck and the energy absorbed in causing fracture in one blow is measured. From the standpoint of ease of testing there are certain advantages of the Charpy specimen over the Izod. From the standpoint of minimum amount of material used for a given number of tests, there are advantages to be gained by using the Izod type of specimen. If the specimen is notched all the way around, then only the Izod type of test can be used. For the case in question, therefore, the Izod type seems preferred.

Design of Specimen

Impact test specimens are not fully standardized as to size, shape, etc. However, certain general practices have become accepted. Most of the specimens are rectangular in cross section with ground surfaces and milled notches. One less commonly used Izod specimen is round in cross section with a milled notch and milled striking surface. Considerable advantages could be gained if the entire work of preparing the specimen could be carried out on a lathe. This can be done by modifying the round type of Izod specimen so as to use a "turned" notch all around the specimen and do away with the milled striking surface. Doing this also makes it possible to put several notches on one length of steel and make a number of tests on the one specimen. Average and, therefore,

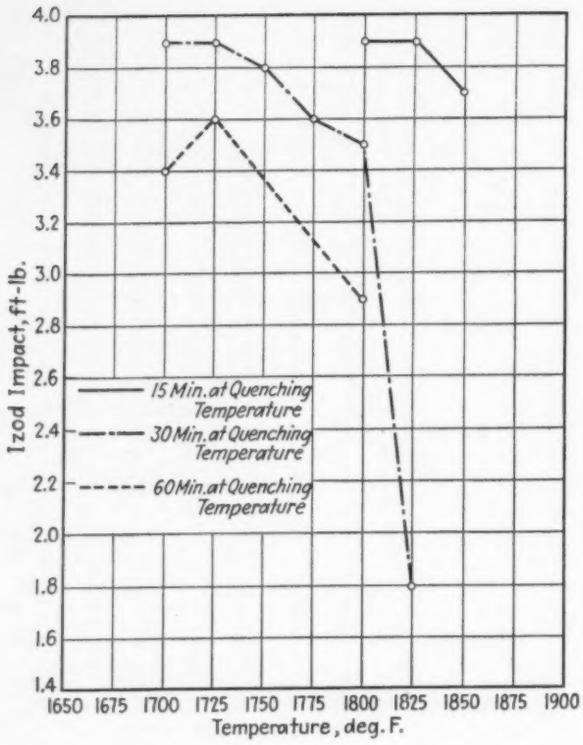

FIG. 3—Izod impact strengths for stainless steel as quenched and tempered to a final Rockwell C hardness of 39.

more reliable results can thus be obtained.

The "Modified Izod" test bar developed and adopted for this work is shown in Fig. 1. The bar can be made up entirely on a lathe by using a formed pointed tool for the notch. "Hogging" or heavy cuts should be avoided at all times in preparing these specimens and the smoothest possible finishing cut should be taken. During notching very light cuts should be taken and the tool kept very sharp, well lubricated and well cooled. It is important that the diameter at the base of the notch and the radius at the base of the notch be maintained very accurately. This, of course, applies to all types of notched impact test specimens.

Program of Tests

Eventually, it was desired to know the best combination of quenching temperature and time and drawing temperature and time which would produce the maximum of toughness in the finished spring. However, it seems as though this had to be approached by stages, first determining the quenching temperature and time which would give full hardness and maximum toughness before drawing. With this as a base, it was possible to proceed in determining the best drawing temperatures and times. Obviously, a greater impact strength could be expected for soft than for the hard condition and, therefore, all impact strengths must be viewed from the standpoint of hardness also. Rockwell hardness readings, therefore, were carefully made and recorded throughout the testing program.

Sufficient material from one lot of steel was selected and from this material, in the annealed "as received" condition, 100 test bars were prepared. After finish machining, the test bars were numbered serially from 1 to 100 by stamping on the long end away from the notches.

Impact Tests on Specimens "As Hardened"

The odd numbered specimens from 1 to 47 inclusive were heat treated and tested as shown in Table I.

The data shown in Table I are plotted in Fig. 2, using the impact strength and Rockwell hardnesses as ordinates and the quenching temperatures as abscissa and plotting the 15 min., the 30 min. and the 60 min. soaks at hardening temperatures separately.

A study of Fig. 2 indicates that the impact strength in the "as hardened" condition falls off rapidly as the quenching temperature is increased. A study of the Rockwell hardness curve, however, indicates that this falling off of impact strength is in accordance with the increase in Rockwell hardness resulting from the more drastic quenching treatment. It was, therefore, quite evident that in order to determine the best quenching temperature, the specimens should not be tested in the "as quenched" condition but should be

TABLE II

Drawing Temperatures for Stainless Steel Specimens

Specimen No.	Hardening Time in Min.	Hardening Temp. in Deg. F.	Hardness as Quenched, Rockwell C	Drawing Temperature in Deg. F.	Resulting Average Hardness, Rockwell C	Average Impact
2	30	1700	45.0	955	38.0-40.0	
4	30	1700	46.6	955	38.5-40.5	3.9
6	60	1700	47.0	960	38.5-40.5	
8	60	1700	46.6	960	39.5-41.0	3.4
10	30	1725	46.0	965	39.0-40.0	
12	30	1725	46.4	965	39.0-40.0	3.9
14	60	1725	48.1	970	38.0-40.0	
16	60	1725	50.3	970	40.0-41.0	3.6
18	30	1750	48.4	973	39.0-40.0	
20	30	1750	49.6	973	39.5-41.0	3.8
22	30	1775	51.5	975	39.0-40.0	
24	30	1775	51.8	975	40.0-41.0	3.6
26	15	1800	48.0	975	39.0-40.0	
28	15	1800	47.8	975	38.5-40.0	3.9
30	30	1800	49.3	975	38.0-39.0	
32	30	1800	50.2	976	39.0-40.0	3.5
34	60	1800	51.5	977	39.0-41.0	
36	60	1800	50.7	977	39.0-41.0	2.9
38	15	1825	51.75	978	39.5-40.5	
40	15	1825	51.0	978	39.5	3.9
42	30	1825	51.50	980	40.0	
44	30	1825	51.25	980	39.5-40.5	1.8
46	15	1850	51.30	985	39.5-40.5	
48	15	1850	51.25	985	38.0-40.0	3.7

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tested in a condition where they have all been drawn back to the same Rockwell hardness.

Tempering Temperatures

Using pieces of the broken impact specimens from the test tabulated in Table I, further experimentation was undertaken to determine the proper tempering temperatures to be used on specimens as quenched from the various temperatures there indicated. In doing this work, it was found that at the start it had to be done by cut and try methods because apparently the tempering temperatures required in the laboratory were somewhat lower than those which seem to be required for similar treatments carried out in a plant. This might arise fom the fact that all drawing in the laboratory was for 2 hr. whereas the drawing time in the plant was something of the order of 45 min.

The experimental heat-treating work was done in an electric furnace in which was placed a heavy copper block with a space inside of it into which the specimens and the thermo-couple could be placed. The heavy copper block was used in order to obtain absolute uniformity of temperature over the entire length of the specimen.

Based on the above experiments, the required drawing temperature for each of the even numbered specimens in the various "as quenched" conditions was worked out. The specimens were then drawn for 2 hr. and tested with results as shown in Table II. The results were plotted, as shown in Fig. 3.

Discussion

A study of the figures in Table II and the curves in Fig. 3, indicates quite clearly that maximum impact strength for a final Rockwell hardness of about 39 was obtained by either a 30-min. soak before quenching at from 1700 to 1725 deg. or a 15-min. soak at a quenching temperature of 1800 to 1825 deg. For a 30-min. soak quenching temperatures above 1725 deg. are objectionable, and for a 15-min. soak quenching temperatures over 1825 deg. are objectionable. These curves also show that a soak for 60 min. at quenching temperature is not desirable for any of the quenching temperatures tried. This, of course, applies to only this particular grade of stainless steel as heat treated in sizes not over ½ in. in diameter.

From the above, we drew the conclusion that for economic and production purposes a quenching temperature of 1800 deg. is desirable and a soaking time at this temperature of not over 15 min.

To determine the effect of various drawing temperatures, certain additional heat-treatments were made and test bars tested as shown in Tables III and IV. These data are plotted in Fig. 4.

There has been mention made from time to time of a brittle range in this type of stainless steel, in which range of temperature the steel should not be drawn after hardening. The curves in Fig. 4 point out very decisively and conclusively that there is such a range and also point out just where this range is for the particular treatment used. Whether the steel has been quenched from 1725 deg. F. or from 1800 deg. F., the im-

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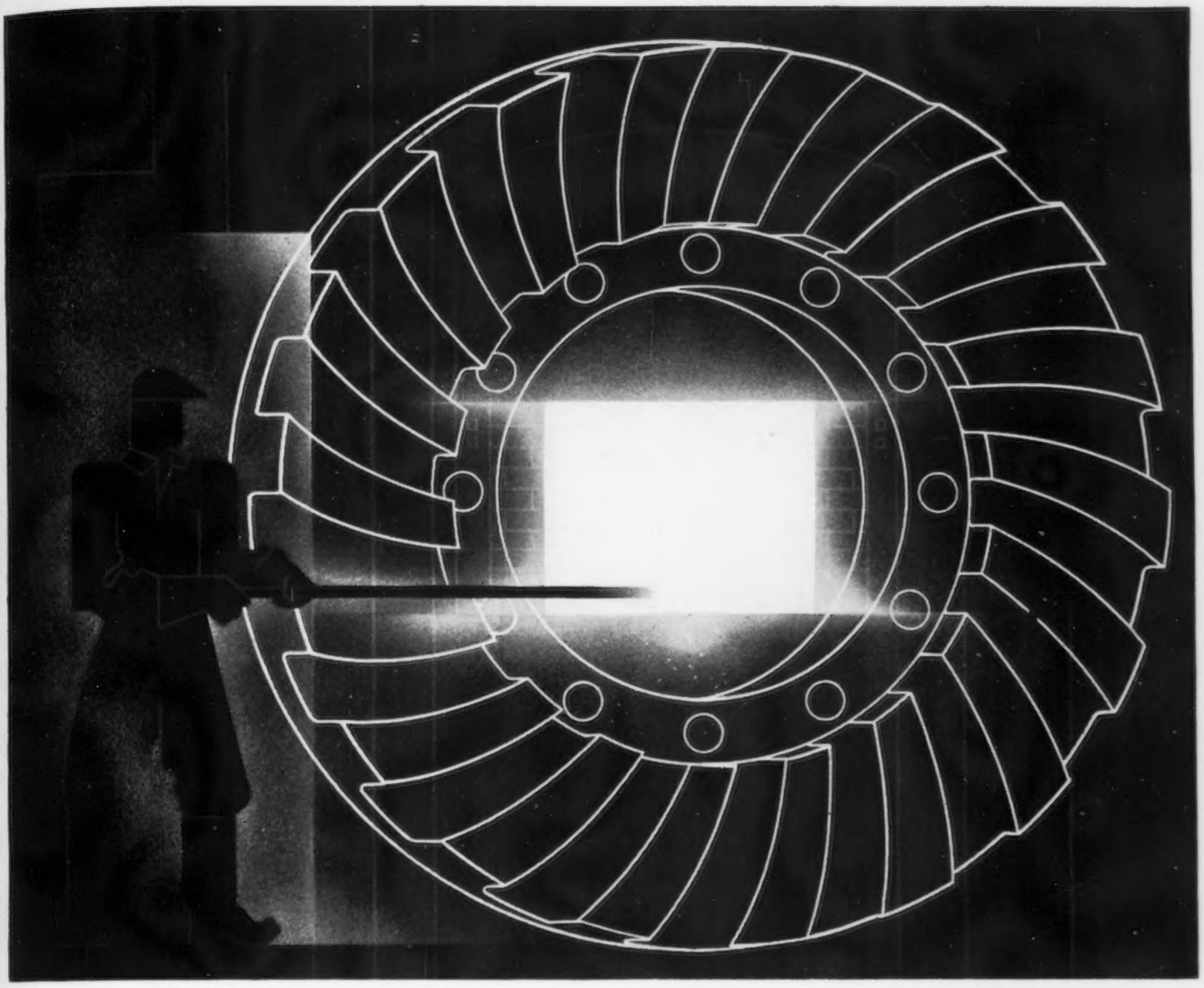

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TABLE III

Hardness and Impact Results for Various Heat Treatments

Specimen No.	Hardening: Temperature in Deg. F.	Hardening: Time in Min.	Drawing: Temperature in Deg. F.	Drawing: Time in Hr.	Rockwell Hardness C Scale	Impact Ft. Lb.	Average Impact
49	1725	30	700	2	45.6	4.0- 3.5- 4.0	
51	1725	30	700	2	44.0	3.7- 3.9- 4.2	3.9
53	1725	30	750	2	44.0	3.0- 3.5- 3.5	
55	1725	30	750	2	44.1	3.5- 3.5- 3.2	3.4
57	1725	30	800	2	44.6	3.0- 3.0- 4.2	
59	1725	30	800	2	43.75	2.0- 2.8- 3.2	3.2
61	1725	30	850	2	45.0	2.8- 2.8- 2.8	
63	1725	30	850	2	44.7	2.5- 2.7- 2.5	2.7
65	1725	30	900	2	45.16	2.5- 2.3- 2.3	
67	1725	30	900	2	46.5	2.1- 2.7- 2.5	2.4
69	1725	30	950	2	39.8	3.3- 2.9- 3.5	
71	1725	30	950	2	39.3	3.0- 3.1- 3.3	3.2
73	1725	30	1000	2	32.0	4.0- 4.0- 4.0	
75	1725	30	1000	2	32.8	4.2- 3.5- 3.9	3.9
77	1725	30	1050	2	25.0	4.5- 4.0- 4.5	
79	1725	30	1050	2	26.5	4.8- 5.0- 4.7	4.6
50	1800	15	700	2	45.0	3.5- 4.1- 4.0	
52	1800	15	700	2	46.3	3.5- 3.7- 4.0	4.0
54	1800	15	750	2	45.5	3.5- 3.5- 3.2	
56	1800	15	750	2	43.9	3.3- 3.0- 3.3	3.3
58	1800	15	800	2	43.75	2.5- 3.0- 2.8	
60	1800	15	800	2	45.0	3.2- 2.8- 3.0	2.9
62	1800	15	850	2	44.75	2.0- 1.7- 2.2	
64	1800	15	850	2	45.2	2.7- 2.7- 2.5	2.3
66	1800	15	900	2	46.25	2.5- 2.1- 2.0	
68	1800	15	900	2	45.6	2.2- 2.5- 2.0	2.2
70	1800	15	950	2	39.1	3.1- 3.0- 3.5	
72	1800	15	950	2	39.0	3.0- 3.1- 3.2	3.1
74	1800	15	1000	2	33.0	4.5- 4.0- 3.8	
76	1800	15	1000	2	29.35	4.0- 4.5- 4.5	4.2
78	1800	15	1050	2	25.0	4.8- 4.3- 4.0	
80	1800	15	1050	2	26.0	5.0- 5.0- 5.0	4.7
82	As Annealed, not Heat Treated				6.3	14.0-17.5-14.0	
84	As Annealed, not Heat Treated				6.0	14.0-17.5-13.0	15.0

pact strength is improved considerably by tempering at 500 deg. F. for 2 hr., followed by quenching. However, if the tempering is carried out at 600 deg. F. or higher, there is a decrease in impact strength.

Going backward down the scale in temperatures from the low figures of the 900 deg. draw, it may be seen that the curve is rising very rapidly all the way to the 500 deg. draw. There is no information available as to whether or not the curve would rise still higher on lower draws before dropping again to the point where it is found for the "as quenched and undrawn" specimens. There is a decided possibility that draws of 200, 300, 400 and 450 deg. would show a drawing temperature which will give even higher impact strength than the draw at 500 deg. It is interesting to note that the Rockwell hardness curve drops slightly to 550 deg. F., then rises to a maximum at 600 to 650 then drops again to 750 deg. F. and then begins a very slight but decided rise in the range from 800 to 900 deg. F., where at this latter figure it has reached a maximum again and then the steel begins to soften quite rapidly. It is also interesting to note that at this maximum point of hardness as the result of draw, the minimum impact strength of the steel is obtained.

Maximum impact strength is obtained for both of the quenching temperatures experimented with at a drawing temperature of from 500 to 550 deg. F. for 2 hr.

The impact strength curve for the specimens quenched from 1800 shows a decided break at the drawing temperature of 650 deg. and a reversal up to the drawing temperature at 700 deg. which is not entirely explainable. It is possible that the errors for the work on the specimens at 650 deg. were additive on the low side and that those for the specimens at 700 deg. were additive on the high side making this jog in the curve. This jog, however, does not interfere with

TABLE IV

Hardness and Impact Results for Various Heat Treatments

Specimen No.	Hardening: Temperature in Deg. F.	Hardening: Time in Min.	Drawing: Temperature in Deg. F.	Drawing: Time in Hr.	Rockwell C Hardness Average: Individual	Rockwell C Hardness Average: Set	Impact Ft. Lb.	Average Impact: Individual	Average Impact: Set
81	1725	30	None		46.3		3.8-3.4-3.2	3.7	
83	1725	30	None		46.4	46.35	3.6-4.0-3.4	3.7	3.7
85	1725	30	500	2	44.5		4.7-4.8-4.0	4.5	
87	1725	30	500	2	45.4	44.9	5.0-4.4-4.5	4.6	4.55
89	1725	30	550	2	43.5		4.3-4.0-4.8	4.4	
91	1725	30	550	2	43.8	43.7	4.0-4.7-4.5	4.4	4.4
93	1725	30	600	2	44.8		4.7-4.5-4.0	4.4	
95	1725	30	600	2	44.5	44.7	4.3-4.5-4.3	4.4	4.4
97	1725	30	650	2	44.7		4.3-4.0-3.9	4.1	
99	1725	30	650	2	46.0	45.4	4.0-4.0-4.2	4.1	4.1
86	1800	15	500	2	46.6		4.3-5.0-5.0	4.8	
88	1800	15	500	2	45.3	45.9	5.2-4.8-4.3	4.8	4.8
90	1800	15	550	2	43.4		4.3-4.3-4.7	4.4	
92	1800	15	550	2	45.6	44.5	4.8-4.5-4.7	4.7	4.55
94	1800	15	600	2	46.5		4.4-4.5-4.7	4.5	
96	1800	15	600	2	45.8	46.1	4.0-4.6-4.4	4.3	4.4
98	1800	15	650	2	46.0		4.0-3.8-3.8	3.9	
100	1800	15	650	2	46.5	46.3	4.0-3.9-3.7	3.9	3.9

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the possibility of drawing very definite conclusions from the work.

From the above work, it was concluded that proper hardening could be carried out by oil quenching from 1725 deg. F. by using a 30-min. soak at this temperature or from 1800 deg. F. by using a 15-min. soak at this temperature.

In view of the touchiness of the steel at the 1800 deg. temperature, an increase of time of small amount at this temperature causing the impact strength to fall off rapidly, it was concluded that 1725 deg. F. for 30 min. was the best hardening practice.

The development of temper brittleness apparently begins somewhere in the neighborhood of 550 to 600 deg. F. Maximum impact toughness was obtained on draws for 2 hr. at 500 to 550 deg. F. It is possible that longer draws and lower temperature draws would yield even better toughness.

Six test pieces of S.A.E. 6150 steel were made and tested for impact strength.

The heat treatment given the six different test bars, the average Rockwell C hardness determined before testing, and the impact test results are shown in Table V.

TABLE V

Hardness and Impact Strength of S.A.E. 6150 Steel

	Hardening Temperature in Deg. F.	Drawing Temperature in Deg. F.	Rockwell C Average Hardness	Impact Strength	Average
H-0-1	1600	1050	38.5	5.0-5.0-5.5	6.66
2	1600	1050	37.3	7.5-9.0-9.5	
3	1600	1050	38.3	7.0-6.5-7.0	
H- 1	1600	800	44.3	5.0-4.5-5.0	4.7
2	1600	800	45.5	4.8-4.5-4.8	
3	1600	800	44.8	5.0-4.5-4.5	

Comparing the results obtained on this chrome-vanadium steel to the results obtained in the long testing program on stainless steel, the conclusion is arrived at that S.A.E. chrome-vanadium steel 6150 as drawn at 800 deg. F. does not have much more impact toughness as indicated by the notched bar impact test than does stainless steel quenched from 1725 deg. and drawn at 500 deg. F.

A stainless steel containing only 0.19 per cent carbon and two low carbon stainless irons were tested.

A number of impact test bars were made up. Some were heat treated in accordance with the recommendations of the suppliers and some in accordance with the best heat treatment found for the regular cutlery grade of stainless steel.

Samples I-1 to I-6 inclusive were made from stainless iron on which was reported a mill analysis as follows: 0.12 per cent carbon, 0.52 manganese, 0.25 silicon, and 12.01 per cent chromium.

Samples S-1 to S-6 inclusive were made from the modified stainless steel submitted on which was reported a mill analysis as follows: 0.19 per cent carbon, 0.52 manganese, 0.17 silicon, and 12.50 per cent chromium.

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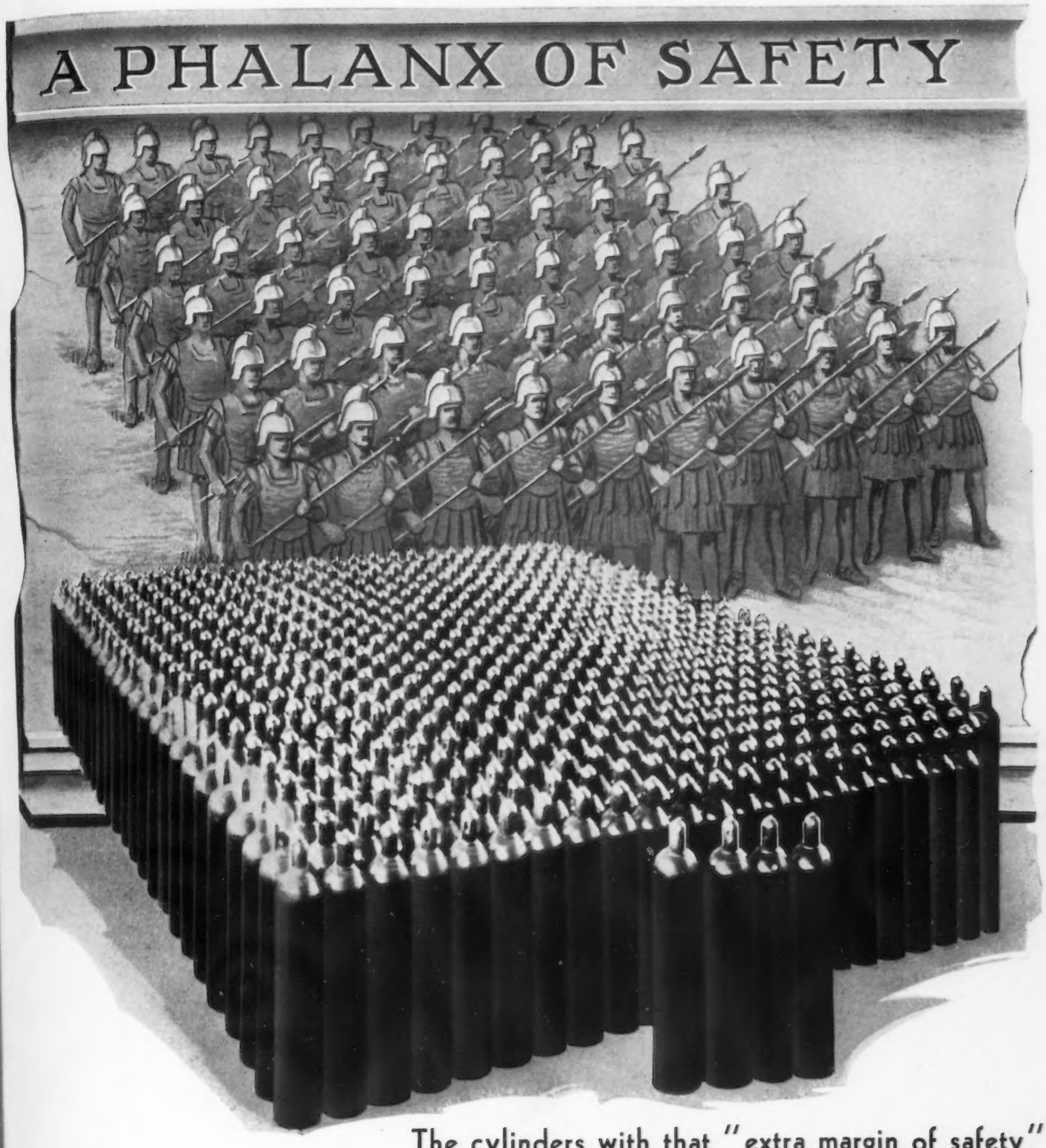

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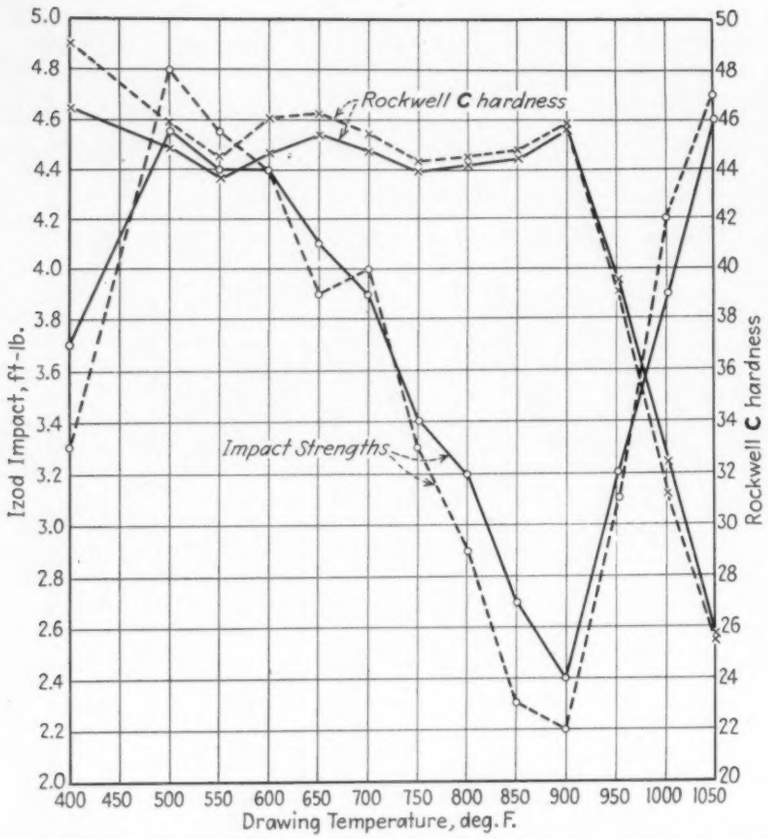

FIG 4—Effect of various drawing temperatures on the impact strength and hardness of stainless steel. These data are shown in Tables III and IV. The solid line represents specimens soaked at 1725 deg. F. for 30 min. and quenched in oil; the dotted line is for soaking at 1800 deg. F. for 15 min. and quenched in oil.

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Samples L-1 to L-9 inclusive were made from the stainless iron submitted by a steel company on which they reported no analysis.

The results of the Rockwell hardness tests and impact tests on the above samples are given in Table VI.

Several things are evident from a study of the results in Table VI. These observations are as follows:

(1) The Rockwell C hardness of heat-treated stainless iron is some 6 points under the hardness of the 0.30 per cent carbon cutlery grade of steel.

(2) The Rockwell C hardness of the heat-treated lower carbon stainless steel was some 6 points under the hardness of the cutlery grade of steel now being used.

(3) A draw of 1050 deg. F. produces almost an annealing of stainless iron.

(4) Maximum impact strength of stainless iron is obtained by a quench from 1725 deg. F. followed by a draw of 550 deg. F.

(5) The impact strength of stainless iron at 37 to 38 Rockwell C hardness is at least double the impact strength of the modified stainless steel of the same hardness.

(6) The impact strength of the properly heat-treated stainless iron is over three times the impact strength of the regular cutlery grade of stainless steel now being used.

(7) A hardening temperature of 1825 deg. F. for 30 min. produces a coarsening of the grain and a weakening of stainless iron.

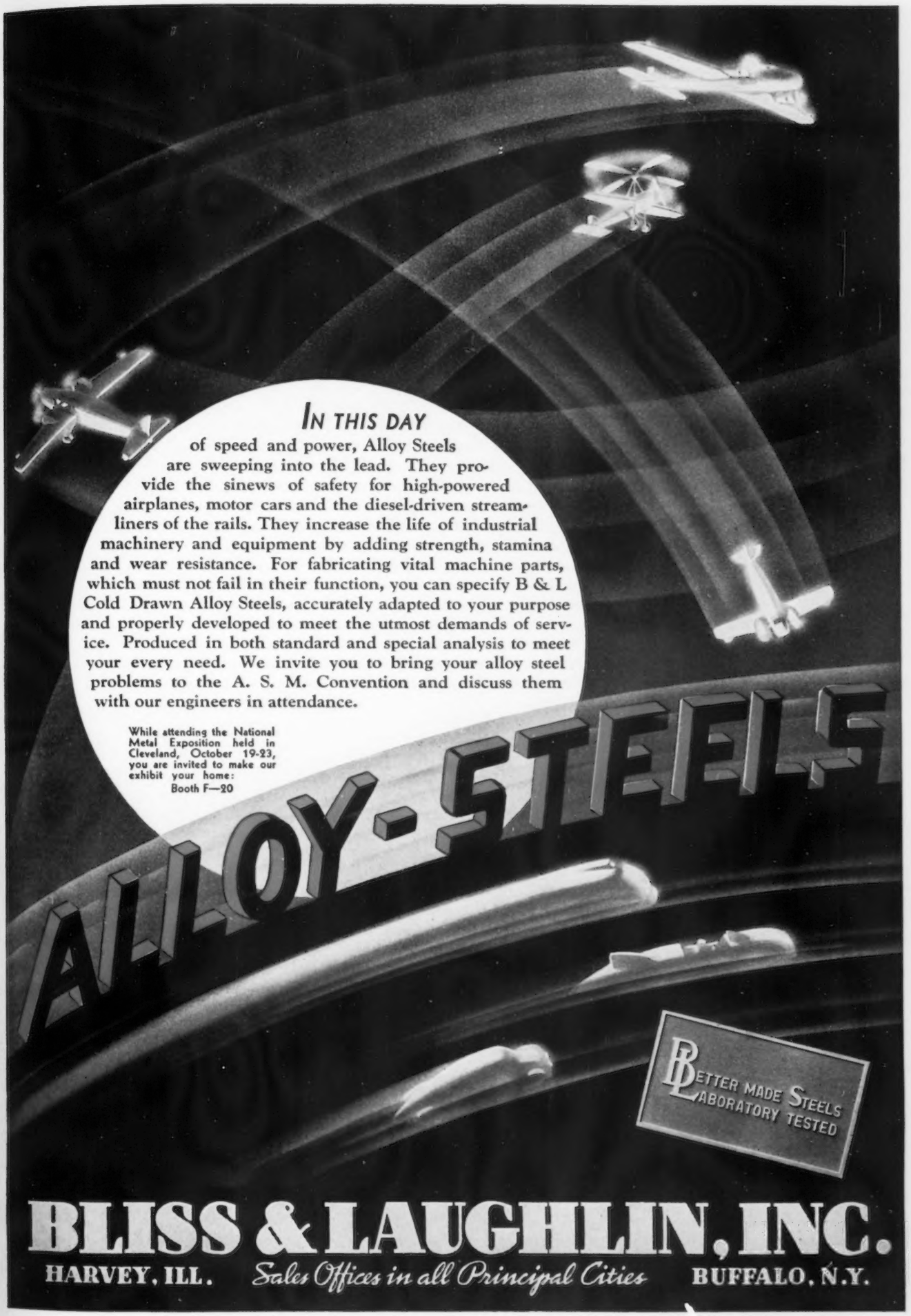
After this considerable study of the cutlery grade of stainless steel and the development of some very interesting information regarding its great sensitivity to time at the hardening heat and further interesting information regarding the position and extent of the temper brittle range, the following conclusions are evident:

(A) If the spring service is such that a Rockwell hardness of C45 to C46 is necessary or desirable, 0.30 per cent carbon cutlery stainless properly heat treated is equal in toughness to chrome-vanadium spring steel of the same hardness.

(B) If the spring service is such that a Rockwell hardness of C37 to C39 is adequate, a stainless iron of about 0.10 to 0.12 per cent carbon and 12.0 to 13.0 per cent chromium, properly heat-treated, has even greater toughness than chrome-vanadium spring steel.

TABLE VI
Impact and Hardness Values for Low-Carbon Cutlery Steel

Bar No.	Hardening Temperature in Deg. F. Time = 30 Min.	Drawing Temperature	Draw Time in Hr.	Rockwell C Hardness	Impact Strength Ft. Lb.	Fracture
Iron						
I-1	1750	600	2	37.5	10 -10 -11	Fine Crystalline
I-2				37.5	10 -10.2-10.2	
I-3				38.0	10.2-10.5-10.0	
			Ave.	37.7	10.2	
I-4	1725	550	2	38.0	12 -14.5-14	Silky
I-5				38.0	14 -17.5-18	
I-6				38.0	17 -17.5-17	
			Ave.	38.0	15.8	
Steel						
S-1	1825	600	2	39.0	7.2- 8.0- 7.6	Fine Crystalline
S-2				39.0	7.5- 8.0- 7.0	
S-3				36.0	7.5- 6.2- 7.7	
			Ave.	38.0	7.4	
S-4	1725	550	2	38.5	7.5- 7.2- 7.2	Very Fine Crystalline
S-5				38.5	7.0- 7.0- 7.2	
S-6				38.5	7.2- 7.5- 7.5	
			Ave.	38.5	7.3	
Iron						
L-1	1825	600	4	36.0	13.0-12.5-12.7	Fine Crystalline
L-2				36.0	13.0-11.5-11.0	
L-3				39.0	13.5-13.5-13.2	
			Ave.	37.0	12.6	
L-4	1825	1050	4	22.5	15.5-16.5-13.5	Coarse Crystalline
L-5				23.5	17.5-13.5-13.0	
L-6				23.5	17.0-14.0-12.0	
			Ave.	23.2	14.7	
L-7	1725	550	2	37.5	16.5-16.0-16.5	Silky
L-8				37.0	16.5-16.0-16.0	
L-9				37.5	17.0-16.5-16	
			Ave.	37.4	16.3	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A REVIEW of COPPER ALLOYS

By M. G. CORSON

Consulting Metallurgist, New York

THE author, a well-known non-ferrous metallurgist, has produced a most ambitious manuscript. In this, the first part of a three-section article, he begins a review of the complete copper-alloy industry by classifying all the alloys, both those rarely used and those in common use, in an orderly and inclusive manner. His conclusion, which will appear in the second and last section next week, is that there is little chance of new copper-base alloys being developed which will have more desirable characteristics than those already in existence.

TO the author it seems that a critical review of the field of copper base alloys is quite timely. With some 6000 years of practical uses and 60 years of research in the background, the industry ought to possess some sort of a clear conception as to where it now stands and what the future possibilities might be.

As, a beginning, it is possible to present the following classification of the needs that are served by copper alloys.

(I) The most important, economically speaking, line of service is represented by the use of copper alloys wherever the much cheaper iron alloys cannot be pressed into service on account of their tendency to rust and because of manufacturing difficulties. Also, copper alloys are used in applications where still better alloys are too expensive.

(II) For articles in which the low corrodibility must be supplemented by fair mechanical characteristics of a reliable nature.

(III) For articles in which the mechanical characteristics must be quite high.

(IV) For articles in which high electrical or thermal conductivity is the most important requirement.

(V) For articles of highly specialized use and of comparatively small economic importance.

Each of these groups can be again subdivided into two classes: (a) cast articles, and (b) wrought articles. Class (a) is practically confined to groups (1) and (3). Very few articles in group (4) and almost none in group (5) are made by casting.

The foregoing five classifications

and two subdivisions (a) and (b) should be kept in mind, as they will be referred to later at frequent intervals.

In the first group of (I) of articles which are made of copper alloys, a low cost is a major consideration. It is desired here that the basic cost of the composition be lower and by no means higher than the current price of copper. Only three alloying elements can satisfy this requirement, namely, iron, lead and zinc.

As late as 1910 it was still believed that alloying copper with iron constituted a terribly difficult job. However, the industry today knows better. Plenty of iron can be alloyed to copper provided the proper kind of iron and the proper equipment are used by the proper men. But, unfortunately, it is known also that unless the resulting alloys pass into the iron-base alloy field, very little if anything of value is obtained for the following reasons:

To improve or change the color of copper as well as to improve even slightly its mechanical characteristics, the alloying element must go into solid solution in copper to a considerable extent, and this is exactly what iron is unable to do.

To be easily cast a copper alloy must melt at a comparatively low temperature (not above 2200 deg. F.). Iron, however, rapidly elevates the melting point.

To be easily worked a copper base alloy shall include little if any separate constituents. Iron, however, forms such constituents of a higher hardness than the ground mass whenever 2 per cent Fe or more is present.

These are only the most important reasons why iron does not form an alloying element of major importance. Binary copper-iron alloys have no place in industry, except as a medium for the introduction of small amounts of iron into other alloys.

Lead has also been considered an element that does not alloy with copper in a satisfactory manner. To mix molten copper with moderate amounts of lead is easy. On solidification, however, lead does not form a solid solution with copper but tends to remain in the shape of small liquid inclusions solidifying at about 605 deg. F. Even in the best case, the presence of lead can influence copper only as so much empty space. And if it gets a chance to aggregate, which is quite logical due to its higher specific density (11.6 against 8.9 for copper), quite a worthless piece of metal results.

On the other hand, the combination of comparatively soft copper with so much of soft lead forms an almost ideal material wherever plasticity and good lubricity, plus fair strength and cheapness are required. This is the case of certain bearings where "plastic copper," an alloy containing about 30 per cent lead, is giving good service.

In the light of present knowledge, the industry is able to cope with the tendency of copper-lead alloys to segregate. This can be accomplished either by controlling the conditions of solidification or by adding certain elements among which sulfur or nickel are worth a special mention. They are added in amounts of not over 1 per cent.

Thirty per cent lead does not represent any specific composition. For that matter, there is nothing specific in any of the binary copper-lead alloys. However, the lower the lead content, the poorer the bearing qualities. No rational purpose would be served by lowering the lead content to less than 25 per cent or thereabouts. Whether higher lead contents could be of increased service is open to conjecture. Efforts are taken frequently to produce alloys with as much as 50 per cent lead, but comparative performance data are lacking.

This article thus designates copper alloys containing lead from 25 to 35 per cent as Alloy No. 1 in Group I Class (a).

Zinc Alloys

Zinc has the distinction of alloying with copper quite easily. On solidification it forms either an alpha solid solution (with Zn less than 28 per cent or a beta solid solution zinc from 38 per cent to 54 per cent.) On further cooling, the composition of the two solutions changes considerably. Everything below 37 per cent zinc becomes alpha. From 46 to 50 per cent zinc, there is a variation of the beta and from 37 to 46 per cent a mixture of both.

Alpha Cu-Zn alloys are not only quite inexpensive, but they possess a high plasticity as well. Economic reasons tend to make alloys with 25 to 35 per cent zinc the most important members of the copper-base alloy clan. This particular group of analyses are designated herein as Alloy No. 2. An enormous amount of articles is made from the rolled stock of these compositions by the way of stamping and spinning. They are used also in the manufacture of tubings.

The mixed alloys (containing both alpha and beta constituents) are considerably less plastic when cold, but far more so when hot. The compositions most used contain from 38 per cent to 42 per cent zinc. They are called Muntz metal and find plenty of uses in the shape of hot rolled sheets and strips, hot rolled or extruded rods and profiles, etc. This classification is designated as Alloy No. 3.

The application of certain processes, especially of die-piercing and spinning, tends to produce in the finished articles a hypersensitivity to the surrounding media and sometimes they crack without being subject to any exterior strain. This phenomenon, called "season cracking" rarely if ever leads to a dangerous situation, but is capable of causing quite an annoyance especially to the manufacturers. While judicious heat treatment helps to eliminate this tendency, it is not so easily applicable. The best way is to reduce the amount of zinc at least to 20 per cent, if not to 10 per cent. Analyses in this group are designated is Alloy No. 4. In general the foregoing low and high zinc brasses are the most valuable members of Group I Class (b).

Any copper-zinc alloy with up to 50 per cent zinc can be cast easily enough into any desired shape, and, in continental Europe, plenty of castings are made of plain brass with anywhere from 20 to 40 per cent zinc. For the most part scrap brass is used for this kind of work, and frequently the alloy is also leaded to insure a better machineability. With due procaution, quite sound castings result.

However, plain brass is specified only by customers who are bent on saving every penny possible. Therefore the value of brasses as members of the Group I Class (a) is slight. Far more important are the red brasses which group around the 85 copper, 5 tin, 5 zinc and 5 per cent lead composition. This particular range is designated as Alloy No. 5.

Why this alloy should form the preferred material for a great number of articles, among which plumbing fixtures are economically rather

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conspicuous, is quite a question. The reason it contains zinc is obvious—the cost is cut down. Lead is used obviously for the same reason and hypothetically because it may penetrate into intergranular shrinkage cavities and so make the article less porous. But why the tin?

This question has never yet been discussed in the literature. It is the writer's observation that alloys containing tin are far more capable of developing a velvety surface and give a feeling of reliability even if the person handling the article does not know whether it contains tin or not. But, be it as it may, "red brass" forms the most valuable member of Group I Class (a).

So far, only five types of alloys belonging to the first group have been named—the group of general utility, so to say. These were: copper lead alloys, three ranges of copper zinc alloys and the red brasses.

Can there be any more alloys in this group? The answer is quite negative; no other element added in substantial amounts will permit the alloys to remain in the general utility group and none taken in very small amounts has yet produced any outstanding improvement in their characteristics.

Copper Alloys in Group II

The second group of articles shall be defined here quite arbitrarily. This group will be made up of alloys that possess from 45,000 to 75,000 lb. per sq. in. strength in the wrought form and from 35,000 to 70,000 lb. per sq. in. strength as sand cast. Another requirement shall be that the elongation in 2 in. may not drop below 30 per cent.

This does not mean at all that alloys serving for the manufacture of articles of this group are called upon to withstand any considerable proportion of the stress comparable to their mechanical characteristics. So, while structural iron works most frequently under actual stresses amounting to 25 and even 33 per cent of the ultimate strength, nothing of this kind is required of copper alloys used for articles in the second group. Their fair physical properties are used mainly as a sign of soundness.

This group is served by the following alloys, Nos. 6, 7 and 8.

High quality wrought binary brasses with 20 to 33 per cent zinc either as annealed (52,000 lb. per sq. in. ultimate strength, 12,000 lb. per sq. in. elastic limit and 65 per cent elongation), or in moderate degrees of work hardness (temper). Same alpha brasses, but with less than 30 per cent zinc and with up to 1 per cent tin or aluminum or silicon. These analyses are arbitrarily designated here as Alloys Nos. 6 and 7.

Variants of Muntz metal (38 to 40 per cent zinc) containing small amounts of tin (up to 1 per cent) and sometimes manganese (up to 2 per cent). In cases where free cutting qualities are of importance as much as 1 per cent lead is added. This group is called herein Alloy No. 8.

Somewhat stronger than brasses and none too expensive as far as composition goes are copper-silicon alloys. They are also quite interesting on account of their strange history.

Over 40 years ago the industrial world knew silicon bronzes. They represented either plain commercial copper alloys or low tin bronzes with microscopical amounts of silicon for which rather vague but quite miraculous effects were claimed. The truth is that silicon taken in small amounts acts only as a deoxidizer and not a particularly effective one in addition.

That much higher amounts of silicon can form solid solutions in copper was also well known for 30 years at least. But the very theory of solid solutions was still vague and the logical conclusion that such alloys might have high mechanical characteristics was not made until Jacobs proved the fact experimentally in the early twenties.

Unfortunately binary copper-silicon alloys were by no means patentable and so could not become proprietary compositions. This was circumnavigated by adding certain elements of small but distinctive value, and so the following came into being:

Alloy No. 9, which contained 2.5 to 4.5 per cent silicon and small amounts of manganese.

Analogous alloys with small amounts of tin: Alloy No. 10.

Same as No. 10 only with small amounts of zinc (up to 3 per cent): Alloy No. 11.

Same as No. 11 only with larger amounts of zinc (10 to 15 per cent): Alloy No. 12.

Same as No. 12 only with small amounts of iron (up to 2 per cent): Alloy No. 13.

The first four (Nos. 9 to 12) are structurally analogous to alpha brass, but the grain size is usually considerably smaller. They possess an ultimate strength of 55,000 to 63,000 lb. per sq. in. when wrought and annealed, and, with a moderate amount of work, hardening brings the strength up to 75,000 lb. per sq. in. with an elastic limit of 30,000 lb. per sq. in.

Alloys containing about 4 per cent Si are somewhat sensitive to work strains and also exhibit the phenomenon of season cracking. Therefore a tendency exists to keep the silicon down to 3 and even 2.5 per cent.

Copper-silicon alloys containing 2 per cent iron show distinctly the presence of a secondary phase—grainlets high in iron and probably carrying considerable amounts of copper and silicon as well. Those grainlets are hard but are not brittle and can stand plenty of hot and cold work. But whether these grainlets really improve the alloy and why they should not decrease their resistance to corrosion are open questions.

Both the brasses and copper-silicon differ considerably from the regular bronzes or copper-tin alloys. The peculiar conditions under which the former crystallize result in the presence of a secondary constituent in the cast billets of alloys with as little as 4 per cent tin. This calls for a time robbing operation of homogenizing the alloys at temperatures of about 1300 deg. F.

While all copper tin alloys with less than 14 per cent tin can be so homogenized and then cold worked, and, while every unit of tin increases the strength of the composition in its annealed state, the cost of the tin and the cost of homogenizing and annealing (tin bronzes harden rather rapidly) cause tin bronzes to be in comparatively small demand. Regular compositions carry from 4 to 5 per cent tin only, while 6 and 8 per cent alloys are made to special orders and 10 or 12 per cent tin bronzes are not heard of in the wrought metal market. The former analyses are designated as Alloy No. 14 and the latter is called Alloy No. 15.

Alloys of the regular type are nearly always treated with small amounts of phosphorus (in the shape of phosphor copper) and are termed "phosphor bronzes" in the trade. Whether phosphorus is of real value remains an open question

to some observers, but it has proved to be a good talking point.

A most important feature of 4 to 5 per cent tin bronzes is their capacity to take a definite "set." This means that they can be easily annealed to the point where all internal stresses are nearly eliminated, a considerable plasticity imparted, and still the article will resist permanent deformations even when the temporary deformation (in operation) is quite high. For this reason all kinds of screens and springs as are by their very use exposed to vibrations are made of "phosphor bronze." No other copper alloy so far developed can compete with them in this direction. Otherwise the use of tin bronzes in the wrought form is rather limited, too limited in fact to warrant a thorough-going study of these alloys by industrial research laboratories either here or in Europe.

A considerable amount of bronze with 5 per cent tin and 1 per cent zinc is used in the United States and England to make pennies, and also for the stamping of bronze medals and tablets. But this use of tin bronzes is most illogical. The cost is high, the alloy is soft and it discolors too quickly. A substitution of aluminum bronzes and cupro-nickel for them is imminent.

Copper-Nickel Alloys

Copper-nickel alloys have also had a very interesting history. They did not develop in a rational way. The Chinese made use of naturally obtained copper-nickel-zinc alloys (packfong) from time immemorial. Their pleasant white-yellowish color was quite impressive and efforts to introduce it into Europe under the names of argentan, alpacka and neusilver began at least 100 years ago.

European metallurgists were compelled, however, to use metallic nickel to introduce this element into copper when making the alloys, and metallic nickel of even 40 years ago came mostly from Caledonia where it was recovered quite primitively in the shape of cubes and rondelles. The purity of this nickel was none too high.

The presence of zinc in the finished alloys helped to check the influence of the impurities in cube nickel and the manufacture of argentan or nickel silver established itself without difficulty. Today nickel silvers probably occupy the second position in importance among wrought copper alloys of the alpha type.

The classification of nickel silvers is quite arbitrary. They represent a continuous system and their characteristics—especially their color-change in a gradual way. Two grades are most distinctive commercially: One with 20 per cent zinc and 10 per cent nickel has a decidedly yellowish color and is comparatively cheap. The second with 20 per cent zinc and 20 per cent nickel has only a yellowish tinge.

As to the binary copper-nickel alloys, the use of rondelle nickel in their manufacture resulted fre-

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quently in all sorts of troubles. And before the microscopists investigated the structures of the copper-nickel series using pure raw materials the belief prevailed that nickel forms intermetallic compounds with copper, their hardness causing all the troubles in rolling.

The microscope and Thermic analyses have shown this conception to be quite wrong. Copper and nickel form solid solutions through the whole range and every composition imaginable can be reduced to wrought shapes, provided the melting and casting of the billets were properly done.

For a time industry was using alloys containing even as little as 1 and 5 per cent nickel. Such alloys have nearly the color of copper and do not exhibit any outstanding improvement in composition to plain copper. Nickel is not a deoxidizer for copper and it hardens the latter metal only gradually, the peak being reached at 70 per cent nickel.

And so, for the reasons of good color, comparative cheapness and easy rolling with the same equipment as possessed by any brass rolling mill the industry came to use a very narrow range of copper-nickel alloys. They contain not less than 25 per cent and rarely more than 30 per nickel. This analysis group is designated as Alloy No. 13.

However, since binary copper-nickel alloys are theoretically known for some 50 years they became quite unpatentable and for the purpose of obtaining proprietary alloys other elements had to be introduced, namely tin (up to 2 per cent) and zinc (up to 5 per cent). These two groups arbitrarily are called herein Alloys Nos. 20 and 21.

Both types of ternary cupro-nickels are undoubtedly somewhat stronger than the plain binary compositions with the same nickel content. But a slightly higher nickel content is all there is needed to obtain the same characteristics. On the other hand there is no information obtainable as to whether the plain 30 per cent cupro-nickel or the 29 per cent Ni plus 1 per cent zinc or the 25 per cent Ni plus 5 per cent zinc alloys are generally more corrosion resistant. All of them, however, are far more resistant to sea water corrosion than brass and for this reason condenser tubings are more and more frequently made of these compositions. These tubes generally are extruded.

As the next and last alloys in the second group, aluminum bronzes with 5 and up to 7 per cent aluminum should be noted. They are easily made and possess as annealed strengths of 50,000 and 60,000 lb. per sq. in. respectively with an elongation of 70 per cent in 2 in. With a moderately hard temper in the first and a slight hard temper in the second, strengths of 70,000 lb. per sq. in. plus 25,000 lb. per sq. in. elastic limit are easily reached. These analyses are classified here as Alloy No. 22.

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stand the addition of small amounts of zinc, tin, silicon, nickel or managanese without going structurally beyond the alpha type. Such alloys are somewhat stronger but the additional strength can be easily obtained by merely raising the amount of aluminum present.

So far, only alloys belonging to the Class (b) (wrought metals) of Group II have been mentioned. It should be of interest to examine Class (a) (cast metals) of Group II.

Cast Alloys of Group II

While plain brasses and also those which carry small amounts of tin or aluminum are easy to cast and the castings are quite dependable, their use in the cast state is rather slight, at least in he United States.

Complex alpha beta brasses carrying small amounts of aluminum, tin and lead and containing about 36 per cent zinc are coming more and more into use for die-casting. This group may be designated as Alloy No. 23.

Complex copper-silicon alloys carrying either manganese or iron to the extent of 1 to 2 per cent possess quite good casting characteristics and are propagandized as a cheaper substitute for tin bronzes (gun metal). However, their use in the foundry is still rather small.

Binary copper tin alloys, which were the only copper base casting alloys known for centuries, came ultimately into disuse. Today they are used rarely if at all. On the other hand, alloys with 10 per cent tin and 2 per cent zinc (admittedly gun metal) or 8 per cent tin with 4 per cent zinc are used to a great extent (and perhaps unwarrantedly) to provide castings of responsible application in most diversified fields. This in spite of the fact that complex alpha beta brasses develop strengths of 60,000 lb. per sq. in. with 40 per cent elongation and complex copper-silicon alloys of 50,000 lb. per sq. in. with 40 per cent elongation against 45,000 lb. per sq. in. and 30 per cent elongation for the tin-zinc bronzes made in the most careful manner. This group may be classed as Alloy No. 24.

Another composition range of tin bronzes is used for the casting of gears and other machine parts. It runs from 11 to 14 per cent tin, must contain no zinc, usually carries very small amounts of phosphorus and small amounts of lead (up to 1 per cent). This group may be called Alloy No. 25.

And a third type of tin bronzes consists of alloys with tin from 5 to 10 per cent and various amounts of lead. The latter is always present to the amount of at least 10 per cent and does not go beyond 30 per cent when the so-called plastic bronzes are obtained. These alloys are used mainly for bearings and bushings, although some of them (with lower lead content) can even be rolled into sheets. This group may be designated as Alloy No. 26.

Even in this field of bearings tin bronzes are not without competition. Complex brasses and complex copper-silicon alloys are bent upon penetrating in this field as well. But will they succeed? Is not there some subtle feature which only a tin bronze does possess? This question is a most vital one. It may have a thorough effect both upon the science of metals and the economics of the alloy industry. Tin deposits are scarce and its value for tinplate and solders is very great. The less tin is used by the copper-alloy industry, the better for other industries.

Cupro-nickels and low aluminum bronzes may also be used in the making of cast articles. No specific difficulty is attached to such use. However, they are hardly so used at all. To the contrary, nickel silvers are frequently cast and their use for castings seems to be on the increase.

This is rather unfortunate. For, contrary to the general opinion, the combination of nickel and zinc does not produce an increased resistance to corrosion. Sea water, sulfate solutions, etc., attack nickel silvers to a much larger extent than even the duplex brasses (Muntz Metal).

As seen, there are some 21 distinct types (from Alloy No. 6 to No. 26) of alloys to satisfy the needs of articles in Group II. The requirements put to articles made of the alloys in this group are quite moderate and there is neither a call nor a way for the development of other alloys answering the same needs.

Alloys in Group III

Most interesting, although by no means of a high commercial importance today are alloys satisfying the demands for articles in Group III, i. e., where high strength and elasticity form the major requirement. The existing compositions may be tabulated as follows:

(1) Regular binary brasses (20 to 30 per cent zinc) can be had with a hard temper developing an ultimate strength of 90,000 to 105,000 lb. per sq. in. They are quite reliable if no further cold work is attempted.

(2) Muntz metal plain and complex can be hard rolled to develop 90,000 to 110,000 lb. per sq. in. strength. Such metal can be used wherever corrosive influences are entirely absent.

Copper tin with 8 to 12 per cent tin, aluminum bronze with 7 to 8 per cent aluminum and silicon bronzes with 4 per cent Si can be easily rolled to a temper corresponding to 120,000 to 140,000 lb. per sq. in. The last two alloys must be used carefully if delivered in this state of hardness or they may develop season cracking.

Cupro-nickel with 30 per cent Ni is too remote from the saturation point (70 per cent Ni) to be capable of acquiring a high ultimate strength by cold working. However, strengths of 90,000 to 100,000 lb. per sq. in. can be reached easily.

Whether cupro-nickels or high-tin bronzes brought to a state of high work hardness are immune from season cracking and can stand corrosive influences is not known.

For high-strength castings it is necessary to rely upon two comparatively old alloys and one new one, namely, high-strength brasses, high-strength aluminum bronzes and a high-strength nickel brass.

High-strength brasses depend for their properties upon the enormous amount of influence exerted by aluminum upon duplex and straight beta brasses. Small amounts of iron and manganese constitute an additional improvement. And while a cast brass with 33 per cent zinc hardly possesses an ultimate strength of 45,000 lb. per sq. in. an addition of 1.5 per cent aluminum raises it to 80,000 lb. per sq. in. With 3.5 per cent Al and small amounts of manganese, the strength goes up to 105,000 lb. per sq. in. This group of analyses are designated herein as Alloy No. 26.

These alloys when of the highest strength are of a pure beta struc-

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ture. They may still possess an elongation of 18 per cent, but are by no means immune to corrosion. It is better—in the cases where corrosive influences are present—to use less aluminum and be contented with a strength of about 90,000 lb. per sq. in. when the structure contains still about 20 per cent alpha. This is the general rule in the casting of ship propellers. Higher amounts of aluminum or higher amounts of zinc produce a beta structure and this for some reasons tends to "dezincify."

Whether this dezincification is liable to cause a propeller to fail is still a question; however, no one cares to see a bright yellow surface turning red, and, to avoid possible troubles, the foundryman has to stick to mixtures of a lower ultimate strength and admittedly more reliable in service.

Cast aluminum bronzes with 9 to 11.5 per cent aluminum and 3 to 5 per cent iron form another type of high-strength casting alloy. They can be had easily with a strength from 85,000 to 100,000 lb. per sq. in. "as cast" and can be heat treated to possess a considerably higher hardness and elastic limit while the ultimate strength also increases by some 10,000 lb. per sq. in. Contrary to their high strength, these bronzes cannot be usefully heat treated. This group is called herein Alloy No. 27.

Another good casting alloy of high strength can be considered as being a modified nickel silver. It contains about 20 per cent nickel and 35 per cent zinc in addition to varying amounts of aluminum and manganese. It also develops 90,000 to 100,000 lb. per sq. in. of ultimate strength and has an elastic limit of 45,000 lb. per sq. in. And it can be heat treated, although reliable information on this scope is not forthcoming. These analyses are called Alloy No. 28.

All these alloys are most capable of being shaped by hot forging, rolling, extruding or stamping, and, in this state, can be brought to a strength of 105,000 to 115,000 lb. per sq. in., the higher figure corresponding to the old high-strength brass mainly. For the two other alloy types these values can be obtained by heat treatment only.

As long as these alloys contain enough of the alpha constituent they can be given a considerable amount of cold work and their ultimate strength brought to 130,000 to 140,000 lb. per sq. in. In this state, however, they become sensitive to season cracking and must not be used under corrosive influences.

High-strength brasses that are practically pure beta or aluminum bronzes with less than 40 per cent alpha in their structure should not be formed at all at temperatures below 930 deg. F. for the brasses and 1100 deg. F. for aluminum bronzes or the articles will develop cracks.

While alpha alloys can be brought to the state of high strength by cold work, alpha-beta alloys by a combination of a proper composition with some cold work and beta alloys by proper compositions and heat treatment only, there are other types of copper-base alloys which develop high strengths by the way of proper composition, plus proper work, plus proper heat treatment, plus proper additional cold work. It is evident from the very mention of the four factors involved that these alloys can not compete with cold worked alpha alloys or alpha plus beta alloys for everyday demands.

Alloys here mentioned depend for the development of a high hardness and strength upon their capacity to form a perfect solid solution (soft) when quenched from high temperatures and to get hardened by the precipitation of an inter-metallic compound when treated at a lower temperature.

The compounds that serve this purpose are:

Silicides of copper, nickel and cobalt (also manganese; chromium; iron, about which see further).

Their formulae are: Cu_5 Si, Ni_2 Si, Co_2, Si Mn_2, Si, Cr_2, Si, Cr_3, Si and Fe_3 Si.

Aluminides of nickel, manganese and of cobalt NiAl, CoAl, MnAl.

Beryllides of copper, nickel, cobalt, manganese, chromium (CuBe, NiBe, MnBe, CrBe).

Titanides of copper and probably of nickel as well.

The most efficacious per unit added are the silicides. Hardening begins with 0.15 per cent Si (0.80 per cent Ni_2 Si) for nickel silicide and with 0.08 per cent Si for cobalt silicide. Five per cent of nickel silicide or 3 per cent of cobalt silicide form the limit of usefulness. They impart to copper a hardness of 190 and 160 Brinell, and an ultimate strength of 110,000 and 95,000 lb. per sq. in. respectively. These groups may be called Alloy Nos. 29 and 30.

With lesser amounts of silicide present (3.5 per cent for Ni_2 Si and 2.4 per cent for Co_2 Si) the alloys develop on heat hardening a strength of 95,000 and 85,000 lb. per sq. in., but the hardened alloys still possess a high plasticity and can be cold worked to 140,000 and 120,000 lb. per sq. in. ultimate strength respectively.

A judicious combination of heat hardening and cold work hardening permits to bringing of the precipitation to a high degree of completion, and alloys result with an electric and thermal conductivity of 60 and 70 per cent of that of pure copper.

Silicides of manganese do not precipitate easily. No hardening is obtained with less than 4 per cent Mn_2 Si being present and it takes 10 per cent Mn_2 Si to attain a strength and hardness comparable to those brought about by 5 per cent Ni_2 Si.

Chromium silicides precipitate easily but do not develop truly high strength alloys because the maximum amount precipitable is less than 0.8 per cent.

Iron silicides do not form at all unless the amount of iron is very high and then they do not go into solid solution in copper except to a very small extent. Hence their hardening effect is small.

The hardening effects of the silicides can be used also to obtain heat hardenable brasses, tin bronzes, aluminum bronzes and cupro-nickels. Of course only nickel silicide is actually so used for the sake of its higher efficacy, easier alloying and moderate price.

Silicide-hardened copper-base alloys are stable at temperatures up to 850 deg. F. They soften rapidly if exposed for a long time to higher temperatures.

Aluminides also form good hardeners but only nickel aluminides are industrially useful.

The hardening effects of precipitated nickel aluminide do not begin to take place if the total amount of nickel and aluminum is less than

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6 per cent. Below this figure both metals remain in solid solution.

From this content on the hardening capacity develops, but far more slowly than in the case of nickel silicide. It takes 8 per cent nickel and 4 per cent aluminum to bring about a hardness of 180 and a strength of 110,000 lb. per sq. in. upon heat treatment. This analysis may be called Alloy No. 31.

However, copper-nickel-aluminum alloys can be hardened to a considerably greater degree than Cu-Ni-Si alloys. With 12 per cent Ni and 6 per cent Al, a hardness of 260 Brinell and an ultimate strength of 130,000 lb. per sq. in. are obtainable upon heat treatment. Even air cooling after hot rolling imparts to them a strength of 110,000 lb. per sq. in. and a hardness of 220 Brinell.

Cu-Bi-Al alloys are far more stable at higher temperatures than Cu-Ni-Si alloys. They can stand for long periods of time temperatures of 1000 deg. F.

They are also more corrosion resistant. On the other hand their conductivities for heat and electricity are low—too much of the added metals remain in solid solution in the ground mass of the alloy.

The hardening with nickel aluminide can be easily applied to all other alpha alloys of copper like 25 per cent brass, 6 per cent tin bronze, 5 per cent aluminum bronze, 30 per cent cupro-nickel, etc. The re-setting alloys possess very good characteristics and the commercially used Cu-Ni-Al brasses develop easily an ultimate strength of 100,000 lb. per sq. in. upon heat treatment. It can be further increased to 115,000 lb. per sq. in. by subsequent cold rolling. These analyses are grouped as Alloy No. 32.

Beryllium Alloys

Beryllides of nickel and cobalt also form very efficacious hardeners and their action starts at very low amounts of beryllium. It continues at least to the same limits as mentioned for silicides and perhaps can go considerably further. The hardened alloys are left in a state of high eclectrical conductivity. But, quite naturally the cheaper silicon forms a too strong competitor to beryllium in there ternary alloys. On the other hand, ternary copper-nickel beryllium alloys are more stable at higher temperatures than copper-nickel-silicon alloys and possess certain additional advantages. This group is called Alloy No. 33.

We must discuss separately the strong alloys in which copper is hardened by the precipitation of its own compounds in a manner not exactly identical but analogous to the hardening of iron by iron carbide.

Here we have three different types of alloys, as follow: copper-beryllium alloys containing from 0.8 to 2.5 per cent beryllium, copper silicon alloys containing from 5.0 to 6.5 per cent silicon, and copper-titanium alloys containing about 3 per cent titanium. These three groups may be designated as Alloy Nos. 34, 35 and 36.

The situation is reasonably clear as far as the first type of alloys is concerned. Copper will dissolve up to 2.25 per cent beryllium at 850 deg. C. (1560 deg. F.) and will not retain in solution more than 0.75 per cent beryllium on heat hardening. The balance, 1.5 per cent beryllium is precipitated in the shape of CuBe making a total of 12 per cent of a precipitation hardener.

And if 4 per cent of precipitated nickel silicide may harden copper from 40 Brinell in the water quenched (soft) state to 120 as heat-hardened, it is clear that 12 per cent copper-beryllide might be expected to bring the alloy to 500 Brinell. Again with a strength increase of 70,000 lb. per sq. in. for 4 per cent precipitated nickel silicide it might be expected that a 210,000 lb. per sq. in. strength increase would result for 12 per cent beryllide.

As a matter of fact such increases in hardness and strength are not actually obtained. Unit for unit copper-beryllide averages up to 420 Brinell and the strength to 160,000 lb. per sq. in., an increase of some 125,000 lb. per sq. in.

Copper-beryllium alloys possess this great strength and hardness only at moderate temperatures and do not stand for any length of time temperatures above 500 deg. F. In this respect alloys hardened by aluminides or silicides are superior.

Copper-titanium alloys are hardened by a titanide of an unknown composition. Only ten years ago titanium and copper were considered unalloyable; at any rate no homogenous binary alloy was ever obtained. Only when pure titanium was produced and the methods of vacuum melting well developed was it found possible to alloy the two metals and the resulting product was found to be capable of heat hardening.

Titanium Alloys

Quite naturally, the system copper-titanium has not yet been fully studied. Titanium is still much too expensive even for experimental work. Considering this and other factors, it may be stated that the outlook for hardening copper with titanium is by no means rosy.

So far the hardness of titanium hardened copper was found to be about 300 against 190 for Cu-Ni-Si system and its strength almost precisely the same as obtainable on nickel-silicide hardening. It possesses, however, a higher amount of plasticity (20 per cent elongation in titanium copper against 15 per cent in Cu-Ni-Si and 8 per cent in Cu-Be alloys).

Far less clear is the situation regarding copper-silicon alloys. According to various investigations it might be expected that a 6 per cent Cu-Si alloy would precipitate upon a proper hardening about 2.5 per cent Si in the form of either the Cu_2Si or the Cu_3Si, compound. In the first case it might mean the precipitation of 30 per cent of Cu_2Si, in the second of 20 per cent of Cu_3Si. And the hardening effect should have been tremendous.

Facts do not bear out this supposition. True enough an enormous precipitation occurs, but the hardness rises to 270 Brinell only while the ultimate strength remains low, inasmuch as the hardened alloy is quite brittle. The reason for it can be seen in the possibility that the precipitate grows immediately to a size at which its hardening action is checked (therefore this low hardness) and that the precipitation tends to occur at the grain boundaries, causing brittleness.

Cu-Si alloys are improved when a considerable amount of aluminum (from 1 to 3 per cent of it is added). In this case they form a good material for hot work, especially extrusion, but instead of hardening them by quenching first and drawing back at a lower temperature next, the inherent tenden-

(CONTINUED ON PAGE 144)

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A few examples of the old and new prices are given in the following table:

SIMFLE RECTANGULAR BLANKS			FINISHED TOOLS, in Lots of 5 to 9			
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1/8"x1/4"x1/2"	$ 3.38	$ 1.80	3/8"x 3/8"x2 1/2"	3/32"x3/16"x7/16"	$ 5.22	$ 4.15
3/16"x3/8"x5/8"	7.78	4.95	3/4"x 3/4"x4"	3/16"x5/16"x5/8"	11.06	8.05
3/16"x3/8"x7/8"	9.92	6.75	1" x1" x7"	1/4"x3/8"x3/4"	16.44	12.75
1/4"x1/2"x1"	16.61	13.50	1 1/4"x1 1/4"x7"	5/16"x7/16"x1"	25.67	22.25

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A Review of Copper Alloys

(CONTINUED FROM PAGE 126)

cy toward excessive precipitation must be checked by quenching from 1400 deg. F. either in water or in oil and leaving the second treatment out. The first medium yields a product with 220 Brinell, 108,000 lb. per sq. in. strength and 22 per cent elongation in 2 in. The second leads to 250 Brinell, 120,000 lb. per sq. in. and 10 per cent elongation. The proper composition of the alloys so treated lies within quite narrow limits. It is possible to use 5.5 per cent Si plus 3 per cent aluminum at one end and 6.3 per cent Si plus 1.5 per cent Al at the other end.

Cast Heat-Hardened Alloys?

Can heat hardenable copper base alloys be used for casting? The answer must be given rather cautiously.

Copper-nickel silicon alloys tend heavily to produce intergranular shrinkage cavities on freezing in the mold. Therefore, while heat treatment of the casting can produce the maximum hardness it does not yield even approximately the strength of the same composition in the wrought state. Whereas 110,000 lb. per sq. in. can be attained easily in the wrought condition, 80,000 lb. per sq. in is practically the limit of ultimate strength for heat treated castings and the plasticity (elongation in 2 in.) tends to be rather low.

Cu-Ni-Al alloys behave somewhat better. A composition that will possess in the wrought and treated state a hardness of 250 Brinell and an ultimate strength of 115,000 lb. per sq. in. with 15 per cent elongation will develop the same hardness but only 90,000 lb. per sq. in. and 10 per cent elongation in the shape of heat treated castings.

The same applies to copper-beryllium alloys. With 2.5 per cent Be the wrought alloy has a hardness of 400 Brinell and a strength of 160,000 lb. per sq. in. with 8 per cent elongation. A heat treated casting possesses practically the same hardness (not less than 380 Brinell) but only 115,000 lb. per sq. in strength and 3 per cent elongation.

Still worse is the situation with regard to high silicon copper alloys. Their hardness when heat treated approaches 300 Brinell but the ultimate strength rarely exceeds 60,000 lb. per sq. in. and there is practically no elongation.

Having completed this review of copper base alloys of high strength, it is desirable to ask the pertinent question whether still stronger alloys might be developed.

The answer is quite simple.

To form a strong alloy when added to copper, the element in question must satisfy the following prerequisites:

There must be at least some range of temperature in which a considerable amount of the alloying element forms a solid solution in copper. If no such range exists the element in question is quite worthless as a strengthener or hardener of copper.

If it forms a solution in copper the question arises as to whether the solution is constant at all temperatures, increases with higher temperatures or vice-versa.

Constant solubility and an enormous hardening action per unit of the element added would form the most natural way of getting a strong alloy. Unfortunately no such case exists for copper-base alloys.

Of the elements that go in solid solution in copper to a considerable extent and stay there, none has an exceptionally efficacious hardening action. Alpha copper alloys do not show over 65,000 lb. per sq. in. strength and 70 Brinell as annealed. Hard worked to the limit, they possess a strength of 140,000 lb. per sq. in. and a hardness of 200 Brinell whether the alloying element is aluminum, silicon, tin or manganese.

The second type of solid solution —the beta appears in a number of alloy systems like Cu-Al, Cu-Sn, Cu-Zn, Cu-Be, Cu-Si, Cu-Sb, Cu-Zn-Al but only in Cu-Zn and Cu-Zn-Al is it sufficiently stable and therefore plastic enough. And it has already been seen that aluminum brasses may possess up to 220 Brinell hardness and up to 115,000 lb. per sq. in. ultimate strength, but no more.

Far better are the chances in alloys which can form saturated alpha structures at high temperatures and then precipitate the excess of the solute at lower temperatures, as is the case of hardening with silicides, aluminides and beryllides.

However, the success of precipitation hardening depends greatly upon the amount of hardener precipitated. And this latter depends upon the ability of small amounts of the hardener to form large amounts of the hardening compound. Here the chances are good only for elements of low atomic weight.

And it may be seen that the best results are obtainable for copper when hardened by beryllium—the fourth lightest element and by titanium which is also a light element. When hardened by silicides and aluminides we again find copper in the company of one light element (silicon or aluminum) and another of a moderate atomic weight (nickel, cobalt).

But of all elements investigated so far only phosphorus might be supposed to act analogously. As a matter of fact it does not, nor do arsenic or antimony act analogously.

Vanadium is also a comparatively light element and it might be expected to behave like titanium. But pure vanadium is almost inaccessible yet and the commercial ferro-vanadium of even a high grade of purity does not seem to alloy with copper.

Of elements still higher in atomic weight the majority do not form solid solutions with copper and some like tungsten and molybdenum do not alloy with copper at all. Hence the chances in this field are non extant.

All told, it is necessary to come to the conclusion that copper-base alloy types of high strength are numbered and that no hope can be entertained to find compositions of exceptional characteristics. Vanadium may still produce an alloy of sufficient strength and hardness to compete with others, but certainly nothing extraordinary can be expected from it.

Ed. Note: — Next week the author will conclude this review of copper alloys and will point out future developments which may be expected.

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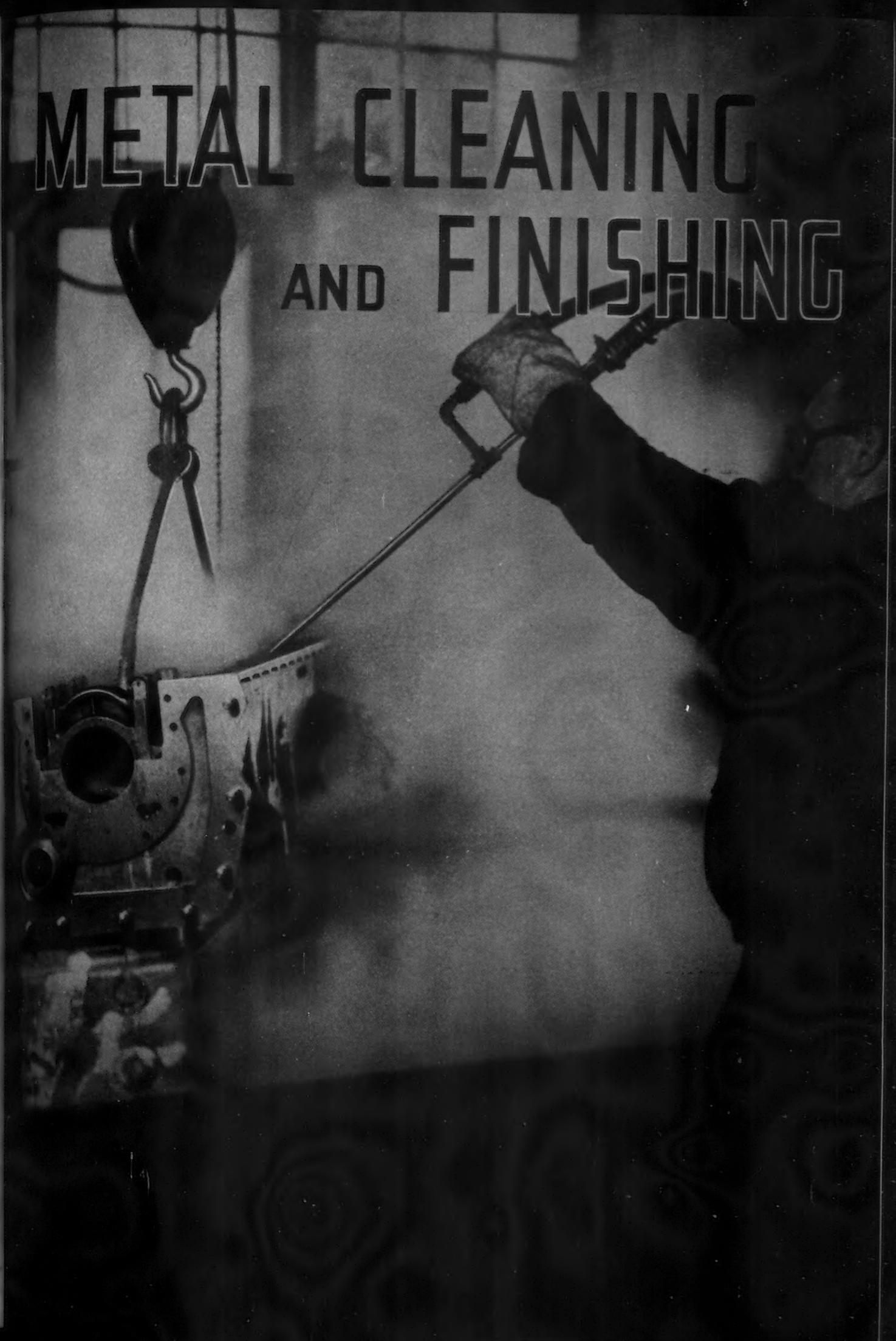

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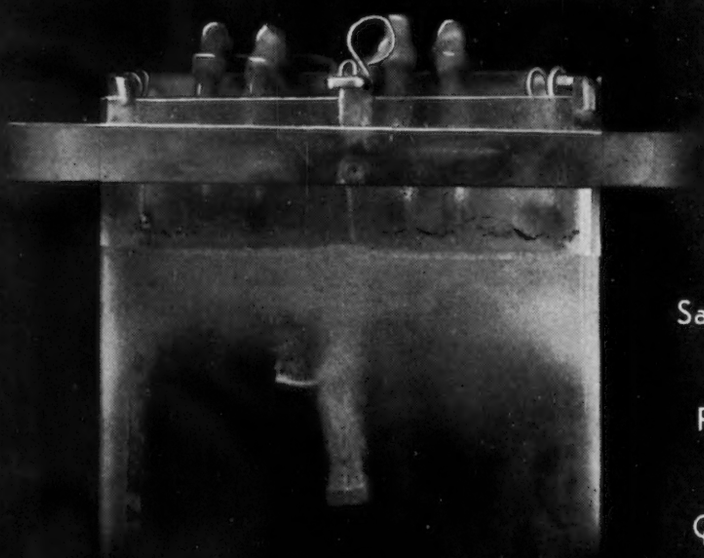

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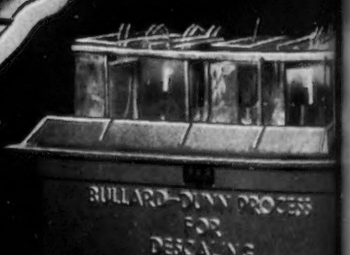

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PROGRESS *in* RUST PROOFING

By HERBERT R. SIMONDS*

THE various processes of rust-proofing form a large part of the total manufacturing sequence in the iron and steel industry, and the opportunities for loss and, conversely, for economies are perhaps greater here than in many other fields.

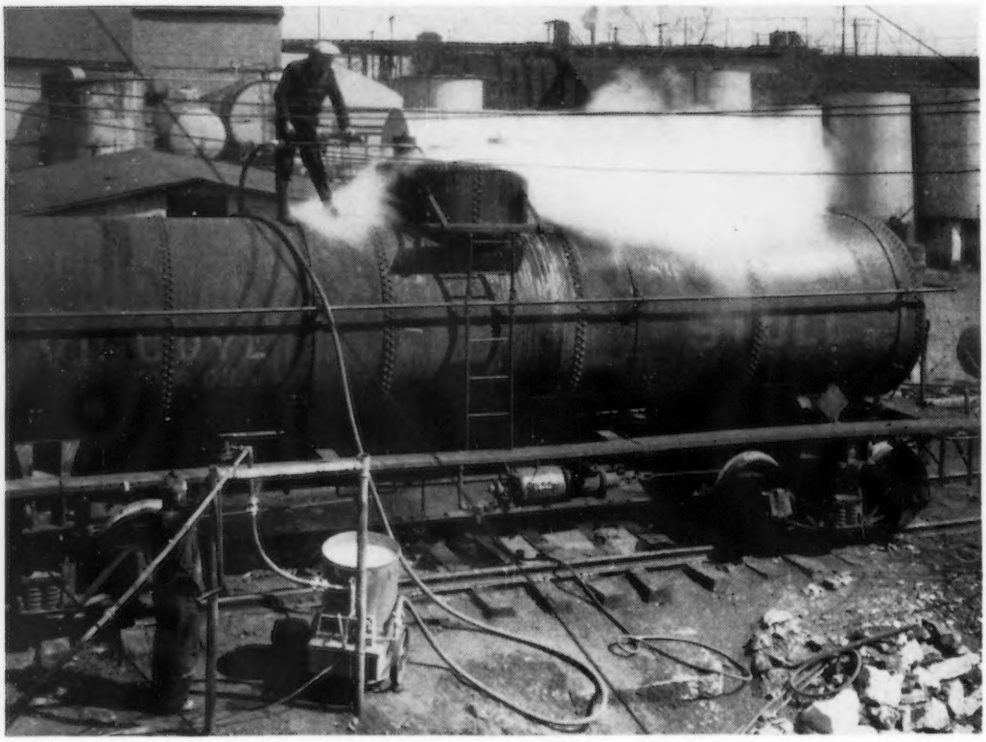
Galvanizing alone is used on more than a million tons of steel products each year. And other processes protect other millions of tons of steel. The subject is too big for much detailed treatment in a single article. Here the author has sought to acquaint the small manufacturer with the many processes available, and to give him some points to guide him in his own selection.

DEMONSTRATE to a manufacturer of a steel product an economy in a machining operation and the chances are he will adopt it. However, suggested economies in rust-proofing are judged as being a different matter. Even though great strides have been made in the improvement of methods and equipment used for protecting steel against rust, the manufacturer is still inclined to consider this part of his production cycle a sleeping dog which he had best let lie.

On the other hand there are progressive managers who ask "What is the best method of rust-proofing? What equipment should be used? What should rust-proofing cost?" These are three vital and apparently simple questions, yet about all anyone can answer to them is a long list of reasons why they can't be answered.

Briefly, the solution to any one problem in rust-proofing depends on such a tremendous lot of variables that it is about as easy to deliberately deal a grand slam hand as to fit this same solution to a second problem. But no ground can possibly be gained without at least attempting a start. So here is a start. This is the reply of one manufacturer who has had long experience in the field of corrosion resistance: "The best method of protecting steel is: first, remove the grease with a good degreaser; second, clean electrically by an approved method; third, coat with zinc in the best modern manner; fourth, dip in a chemical bath to produce either a phosphate or chromate coating, and, fifth,

*Vice-President of Metal Products Exhibits, Inc., Rockefeller Center, New York.



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RUST-PROOFING of large equipment in service may be done by power spraying including, first, a cleaning operation, then, a phosphate coating followed by spray painting.

o o o

spray with a good protective paint."

Such generalities are of little use to the small manufacturer who wants details and plenty of them. He wants to know how to clean, how to galvanize, and how to paint his particular product, and he wants the cycle so mapped out that no mistake is possible. This involves not only knowledge of the solutions and processes, but an analysis of equipment and material handling as well; for very often the decision in a specific rust-proofing problem is primarily a matter of conveyers, tanks and drying machines.

It is pretty generally agreed that a zinc plate on steel is the most practical basic operation on which to build a complete rust-proofing procedure, yet even with zinc plating there are many variations. The manufacturer must choose between hot-dip galvanizing and acid or cyanide electrogalvanizing, and, having made this choice, he then has many details still to work out, based on quantity production, desired thickness for coating, and character of final finish.

Some of the more common types of steel protection are the following: Zinc, cadmium, tin, and nickel plating; phosphate or chromate coating; painting; metal spraying; sherardizing. In addition to these general types there are many special processes, and of course new schemes for steel protection are constantly appearing, some with merit and some without.

One new scheme which may have merit in specific cases is known as Duro-Spray and comes from England where it was developed by the same man who originated sherardizing. Here is an outline description of it. Onto cleaned steel a special priming coat is applied, and while this primer is still in a "tacky" condition a stream of finely divided metallic powder is blown over it by compressed air, thus producing a fairly compact, uniform metallic layer, after which the surface is painted in any desired manner. This process is claimed to cause the underlying steel to be preserved at the expense of the outer compact metal coating.

Galvanizing

Zinc plating or galvanizing is by far the most prevalent method of steel protection. In this country some million tons a year of steel products are thus protected. The long list of items includes nails, screens, nuts and bolts, hardware, pipe, corrugated sheets, conduit, and parts for radios, typewriters, adding machines, washing machines, and automobiles.

Two major methods wage a strenuous and sometimes bitter battle for this large volume of rust defense business. They are represented by the hot-dip and the electroplate camps, with the Preece test campaigning for the former and the "pure metal" slogan working hard for the latter.

Naturally where so many authorities take quite definite stands in favor of one camp or the other, each camp must have some proper

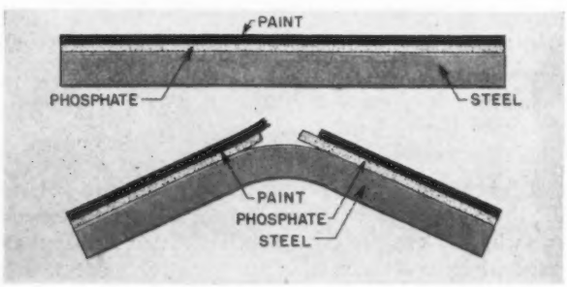

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DIAGRAM showing the effect of bending on hard coatings: As the phosphate coat is hard and brittle, it will not bend with the metal, but breaks away and peels off, carrying the paint along with it.

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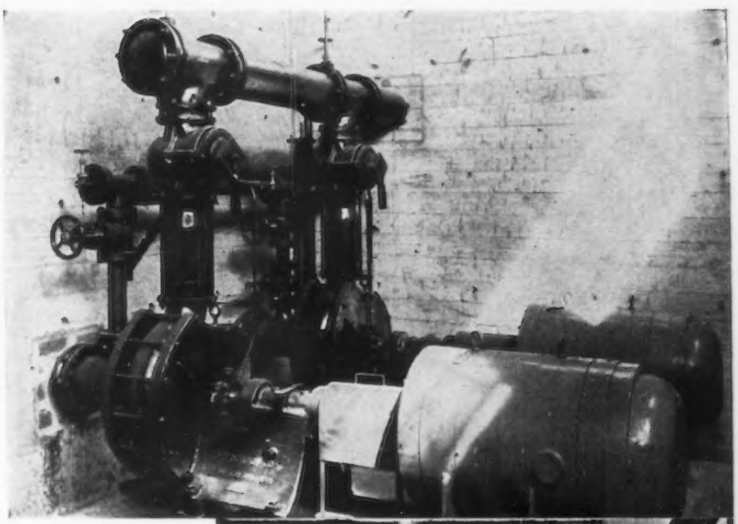

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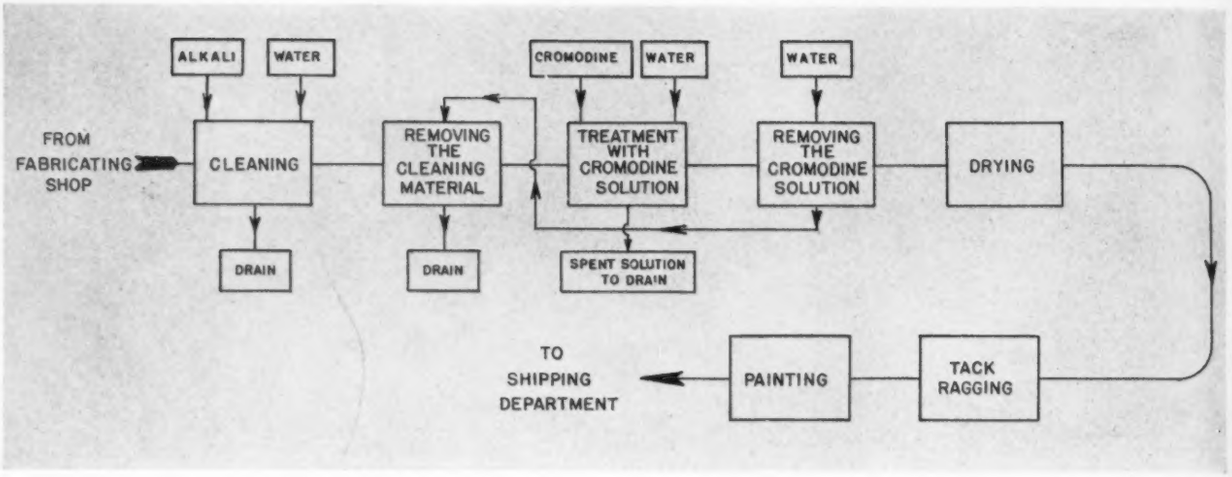


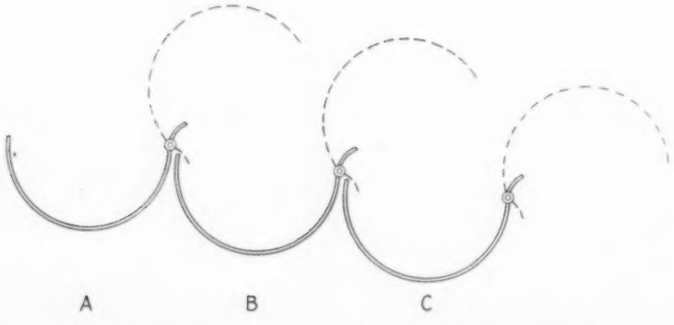
FLOW-CHART of the Cromodine rust-proofing process.

claim to superiority on certain points. However, for the small manufacturer of miscellaneous metal parts the difference between the two need not be great either in resultant protection or in cost. For his convenience, some of the points of difference may be mentioned, although with reservations, for on almost every point exceptions will be found.

Hot-dip galvanizing is simpler and requires less complicated and less expensive equipment. It produces a coating which is an alloy of zinc and iron in distinction from the nearly pure zinc coating of the electroplating process. In the simple dip of steel into molten zinc the resultant coating is less uniform in thickness than with electro-deposition, but subsequent wiping or swabbing may give the dipped part a coating of equal uniformity. The pure zinc coating tends to be more ductile than the zinc-iron alloy coating. Parts must be dry for hot-dip but may be placed wet into electroplating tanks. The hot-dip process is frequently indicated by the product itself. Thus, a wire mesh industrial screen would be hot-dipped because this action automatically solders the joints whereas electrogalvanizing does not.

Type of exposure in service is another condition to be considered, as the pure zinc resists certain factors more readily than the alloy and, contrariwise, the alloy produced by hot-dipping has its set of factors in the service environment which it more readily resists.

It is easier to build a large tank for hot-dip galvanizing than it is to build a large tank for electrogalvanizing, and because of this the larger fabricated structures are usually hot-dipped. However, when the structure gets too large for a practical size of tank, the individual members may be electrogalvanized before fabrication. This has a disadvantage in that the members often become abraded by the fabricating process and thus lose protection at important points near joints. To offset this, the necessary heating of members during hot-dipping may cause warping. Other points to consider are need of keeping hot-dip tanks hot at night, centrifuging or tumbling after hot-dip to prevent parts such as bolts from freezing into a solid mass, and possibility of thicker coats by electroplating.



FOR dumping parts from one solution into another, this device has been used. Hopper A tips, as shown by dotted lines, and dumps into hopper B, and B into C, etc. This design is used by U. S. Galvanizing & Plating Equipment Corp.

Phosphate Coatings

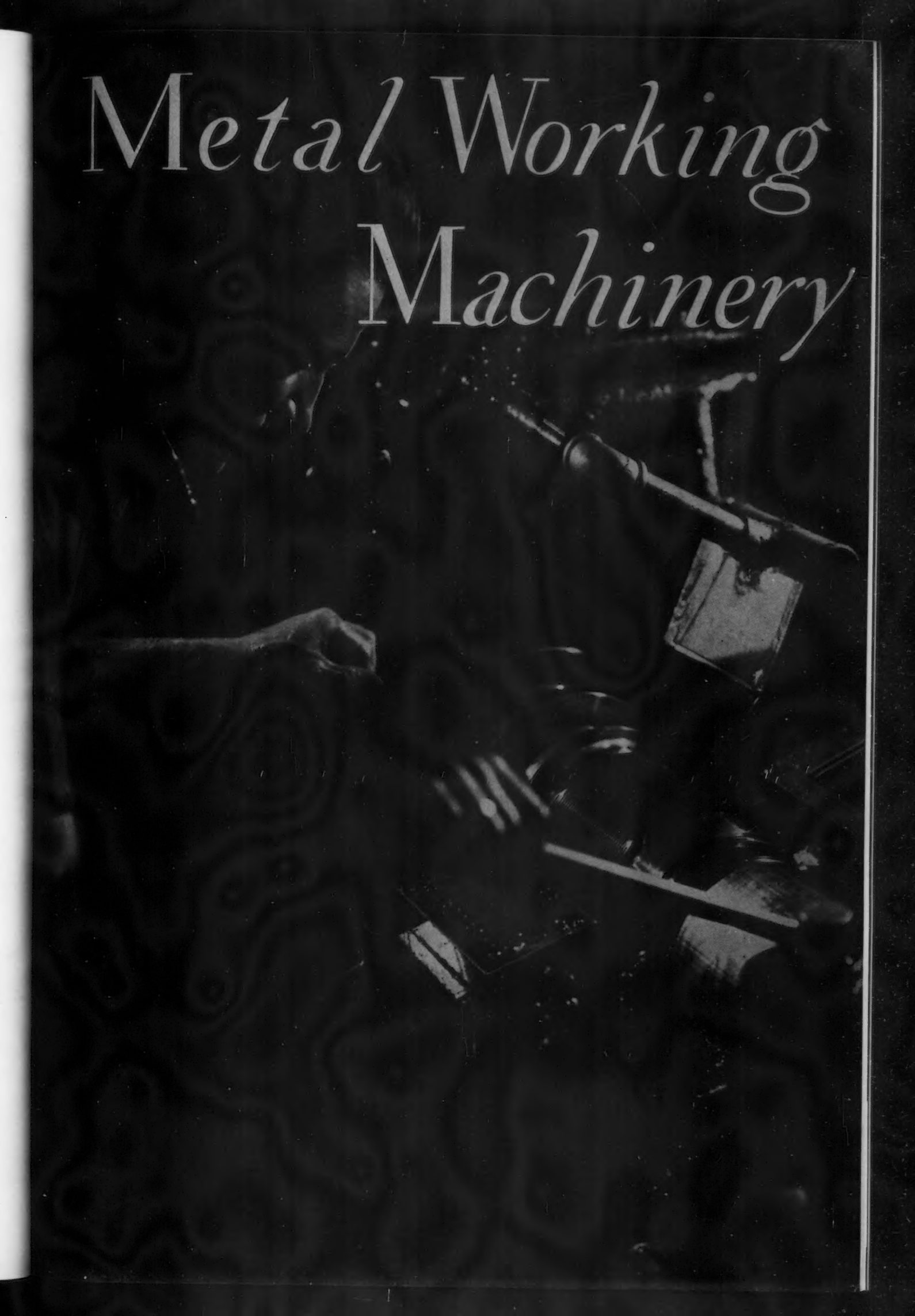
In Parkerizing, steel parts are boiled in a solution of iron and manganese phosphate. By this means a heavy crystalline layer of phosphate is formed on the metal. The coating itself is mostly iron and managanese phosphate and, while a protection to the base metal, is subject to rust unless protected by oil or paint.

The process is simple and known as fool-proof. That is, considerable latitude is permissible in the different variables. The surface produced is crystalline and rough and forms an excellent base for paint for all products where a lustrous, smooth finish is not necessary.

A variant of the Parkerizing process, known as Bonderizing, produces phosphates of iron and copper on the steel. This has the advantage of being less subject to corrosion before painting. Thus, parts which have been bonderized may be shipped or held in storage for short periods without any danger of surface deterioration.

The phosphate coating may be applied to a zinc surface as well as to a steel surface, and from this is developed one of the very best methods for preserving steel. That

Metal Working Machinery



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USE of TURNING TOOLS

By F. SCHWERDTFEGER

TO attain the maximum performance from tools, the relations between many factors have to be studied. The results of some recent systematic investigations are surveyed in this abridged translation of an article which appeared several months ago in *Maschinenban der Betrieb*. The reproduction here is made possible through the courtesy of *Metal Treatment*. Attention is given in the first place to the relations between tool life, cutting speed, chip dimensions and the hardness of the material being cut. The design of tools, the stresses imposed on the tool shaft and the form of tool holders are then considered, and, finally, cooling and lubrication are dealt with.

THE metal to be cut, the tool, and the lathe, are the three factors concerned in turning, and for a complete understanding of the operation their interrelation must be studied and appreciated. Much can be gained from accurate personal observation and from the experience of others, but the results achieved by modern research methods must not be neglected.

As a starting point for consideration of the machining processes, it is advisable to consider the generally applicable relationships that have been shown to exist by earlier investigators. In view of the complex system of interacting factors depicted in Fig. 1, it would be a hazardous undertaking to enunciate the precise principles underlying any machining process. Even at the best, only tendencies and how these are borne out in practice can be discussed. Through an understanding of these tendencies, the engineer will be enabled to solve for himself many of the turning problems arising in the workshop and thus to evolve his own practical "tips."

Probably the most important consideration in any machining process is the choice of the correct cutting speed, and, second, the correct cutting pressure. For the former determines the output of the machine tool and the latter is bound up with the power consumed, the durability of the tool, and the smoothness of the turning. The correct cutting speed is a matter for interpretation, according to the special requirements of any

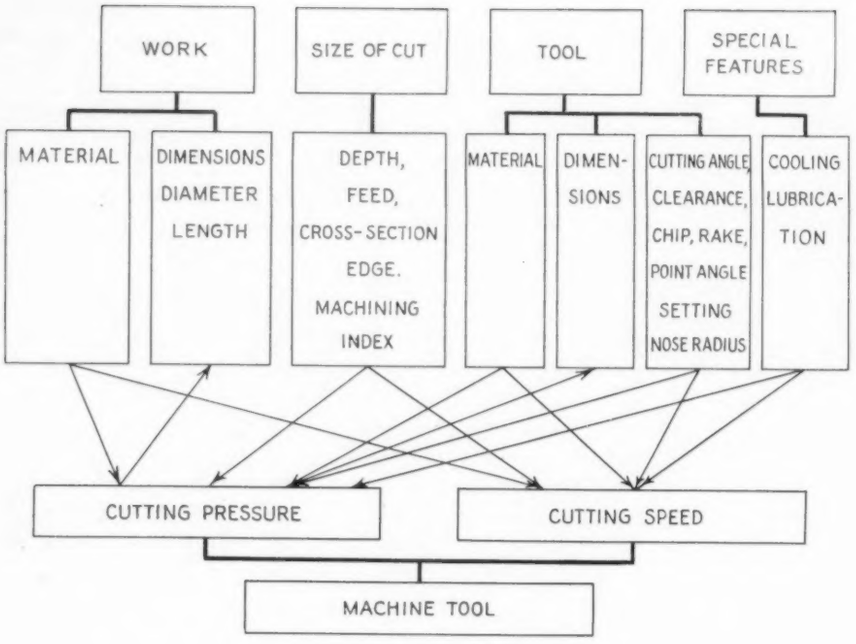


FIG. 1—There is a complex system of interacting factors underlying any machining process. This graph shows the relationship of the various factors in turning.

job, but nowadays the correct speed is taken as that at which a freshly ground tool will cut for just one hour before becoming completely blunted. This speed, the "hour cutting speed," is designated by the symbol v_{60}, and is sometimes called the "economic speed" since it has been estimated that with a tool life of one hour the relationship between output per cut and the time lost in regrinding the tool reaches an optimum value.[1] This applies only to ordinary lathes for general work, and, where tool setting absorbs more time as in turret or automaticlathes, the cutting speed must be chosen to give a longer tool life, say, 250 or 500 min. instead of 60.

The "hour cutting speed" is determined by tedious and costly turning tests. With conditions otherwise maintained as constant as possible, the cutting lives of a series of identical tools are found for different cutting speeds. The values for tool life so obtained, when plotted against cutting speed on double logarithmic axes, fall fairly well on a straight line, as shown in Fig. 2. From such a set of graphs the following conclusions may be drawn:

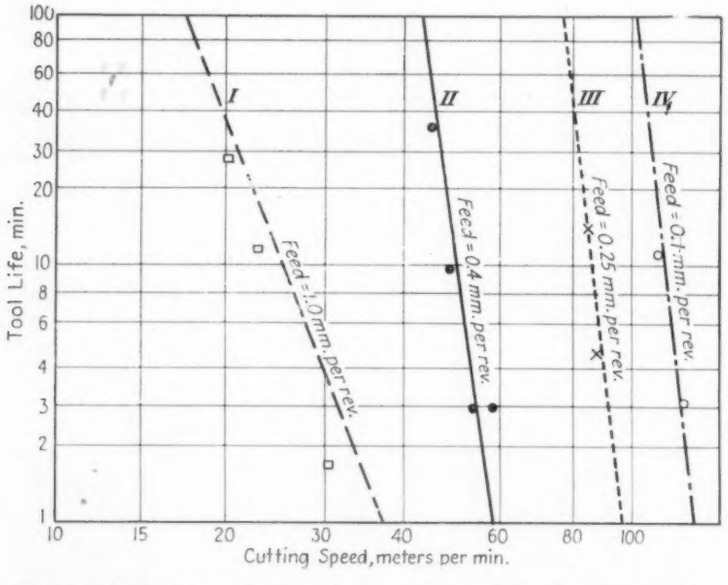
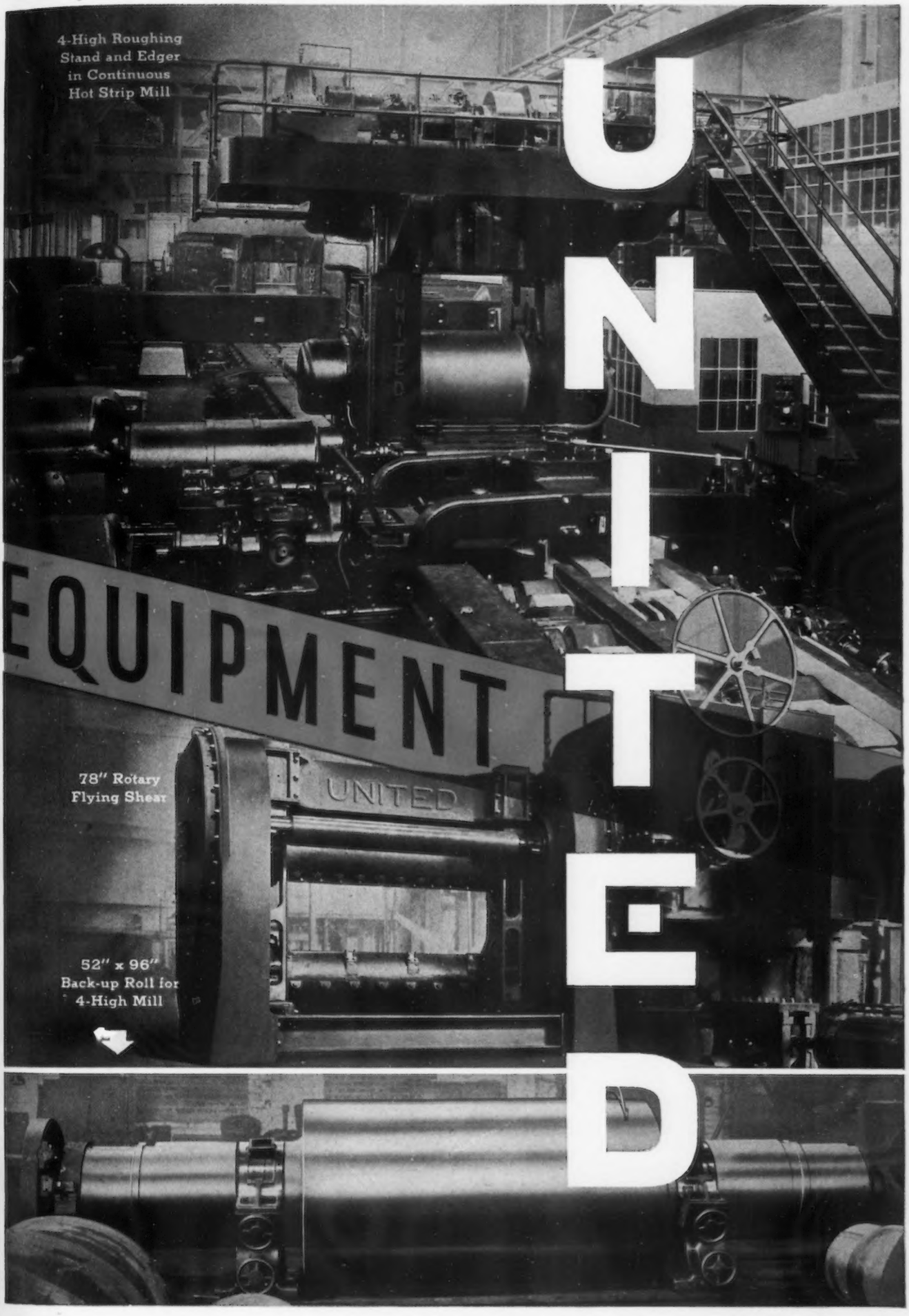


FIG. 2—Tool endurance curves. For a constant depth of cut and varying feed, the tool life is found for varying cutting speeds and plotted in double logarithmic axes. The depth of cut a = 1.5 mm.

(1) The "hour cutting speed" decreases with increased feed.

(2) The graphs for different feeds deviate in a fanlike manner. Therefore, with decreasing feed the tool life becomes more sensitive to variation of cutting speed. That is, with a small feed the tool life will be greatly increased by a relatively small decrease in speed, whereas with a heavier feed the speed must be considerably reduced to bring about any marked improvement in the life of the tool. From the graphs in Fig. 2 it may be found that for a feed of 0.1 mm. per revolution a tool life of 20 min. is obtained when the cutting speed v_{20} is 110 meters per min., and 60 min. when v_{60} is 104 meters per min., that is, 5.5 per cent less. For a feed of 1.0 mm. per revolution, v_{20} is 22 meters per min. and v_{60} is 18 meters per min., a difference of 18 per cent.

(3) A more careful consideration of the graphs and particularly of the actual test results elicits the following facts. The scatter of the test results amounts to about ± 2.5 per cent if calculated on the values for v_{60}, but if based on tool life instead of cutting speed, the scatter amounts to ± 50 per cent, and, in the steeper graphs, to even more. Such deviations occur in carefully supervised cutting tests on a homogeneous material with carefully heat-treated and accurately ground tools. It follows from this that the estimated life of 60 min. for a certain cutting speed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will only be obtained in practice as an average for a large number of tools. With smaller feeds the scatter of the results becomes greater, and since in certain cases the various distributing factors may have an additive effect, the variation in performance frequently obtained from tools in service may thus be explained.

If tests be carried out on a series of materials of different composition, but with similar cutting properties so far as chip formation is concerned, it can be shown that with increased hardness of the work the cutting pressure rises and the lower must be chosen the "hour cutting speed," as shown in Fig. 3.

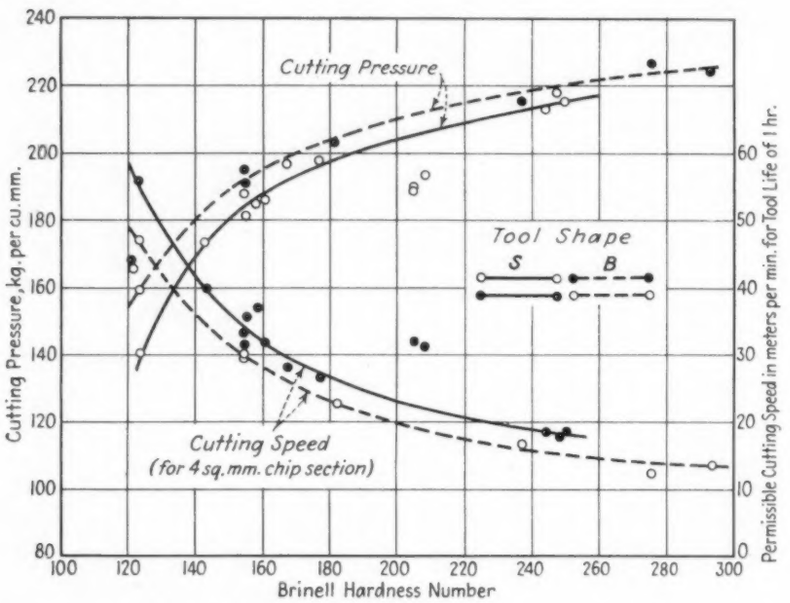

FIG. 3—Influence of Brinell hardness and cutting pressure on cutting speed. With increasing hardness the cutting pressure increases and the "hour cutting speed" falls. Tool B was a roughing tool with a chip angle of 12 deg., setting angle of 43 deg., and a rake angle of + 6 deg. Tool S had a chip angle of 20 deg., a setting angle of 40 deg., and a rake angle of + 18 deg.

The removal of metal in a lathe results in severe plastic deformation of the turnings. The work expended in this process is related on the one hand to the cutting pressure and on the other to the quantity of heat evolved at the edge of the tool, so that the conditions under which the tool works and the practical "hour cutting speed" may be represented by the cutting pressure or by the temperature reached during machining. If the temperature at a tool point during the course of a long lathe cut be measured continuously, it will be found that variations in temperature correspond precisely with variations in cutting pressure. Relationships also exist between cutting speed and the ductility or machineability of the material to be cut, but are restricted to comparisons between materials with similar structures and with similar structural components. With the appearance of any structural constituent affecting the interaction between the tool and the work, or altering the wear characteristics of the system, large deviations from standard tool performance must be expected. The hardness or tensile strength of a material give no indication of the wear properties, still less are the wearing characteristics intrinsic properties of one material, but are determined by the interaction of two separate bodies. Such considerations are neglected in studies of the machining process from the standpoint of heat evolution only, or in studies that seek to relate machineability to tensile strength. In view of this many of the recommendations made in the past are based on misconceptions, but in spite of the limitations of the methods employed the results of such work are not to be wholly condemned.

Old Machining Graphs Still Used

The v_{60} values, which were proposed in Germany in 1925-26 after extensive researches, formed the first reliable guide to machining speeds for application in the workshop. They have been used in the form of tables and graphs and are of considerable value at the present time. The values of cutting speeds given in these tables are generally based on the cross-section of the chip removed by the tool.

Wallichs and his co-workers have shown, however, that the dimensions of the chip rather than its cross-section should be the base to which cutting speeds should be related. Thus, a twofold increase in the feed reduces the v_{60} value twice as much as a similar increase in the depth of cut although both alterations have the same effect on the cross-section of the chips.[3] On the results of his work, Wallichs has developed the diagram for steels shown in Fig. 4. These graphs incorporate the necessary allowances for tensile strength or Brinell hardness of the material being machined and they therefore permit the most economical cutting speed to be read off for any given chip dimensions, when machining structurally similar materials. A similar diagram has been prepared for cast irons.[4] [5]

The dotted line, Fig. 4, shows the method of using the diagram. Starting with the given depth of cut at the extreme right of the diagram the line is followed until it intersects the tool feed. From this point the transfer line is followed until it meets the point corresponding to the Brinell hardness or tensile strength of the work. From there a horizontal enables the "hour cutting speed" to be read off on the vertical axis. Continuing the horizontal until it intersects the line corresponding to the chip cross-section (product of feed and depth of cut) the vertical at that point gives the weight or volume of metal removed in unit time.

All the work hitherto dealt with is concerned only with roughing cuts, but Leyensetter has sought to develop a general solution of the problem by means of his machining "index." This term refers to the quotient I/a.s., where I is the length of the cutting edge on the tool actually engaged with the work, a is the depth of cut, and s the feed, the product a.s. being the cross-section of the chip. In general it may be said that ordinary lathe operations have machining

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indices varying from 0.2 to 2.5 mm., the lower values being for roughing cuts and the high values for finishing cuts. The evaluation of a machining index has the disadvantage that it refers only to one type of work, roughing or finishing cuts as the case may be, but against this may be set the fact that a single index may serve for a number of tool profiles so long as I/a.s. is constant, whereas Wallichs' diagram refers to one type of tool only, with a setting

If the material be hard, as in martensitic steel, but capable of being softened by heat treatment, then the cutting conditions must be varied so as to develop at the tool point a temperature sufficiently high to soften the metal being removed, the chip coming away at a red heat. The feed must be kept low (0.05 mm. per revolution) and the tool must be of a type capable of withstanding the high cutting temperature. Therefore a carbide tool is preferable, and, in view of

siderably reduced and the temperature should be kept as low as possible by the use of a liquid cutting compound. The feed should be large so as to reduce to a minimum the number of abrasive particles coming into contact with the edge of the tool. For this type of work a prime necessity is a heavy and powerful lathe, and the tool should be of wear resisting high speed steel, or, better, a carbide tool of a type suited to the particular work in hand.

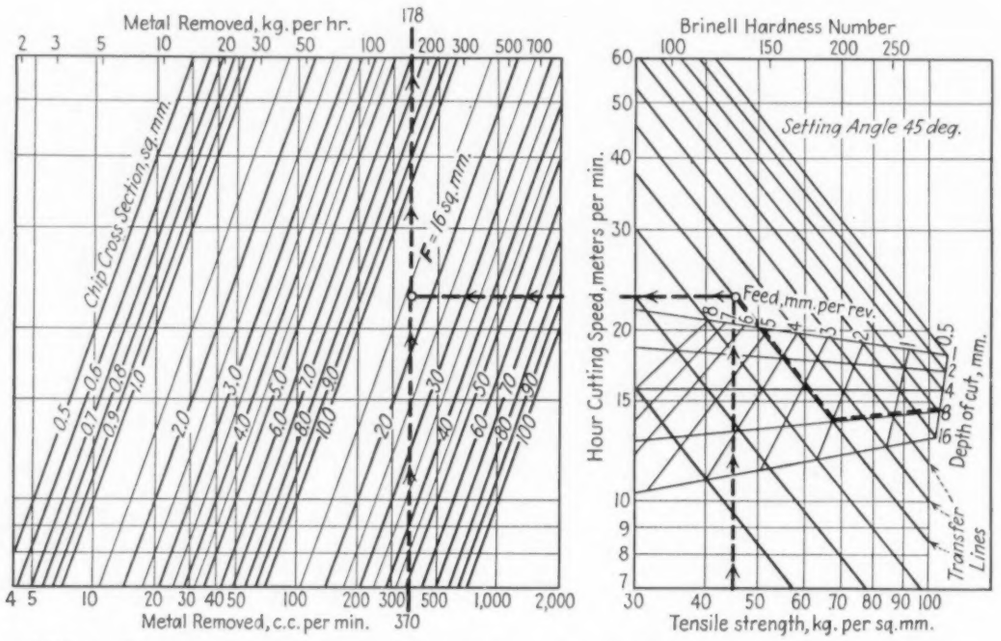
Metal Removed, kg. per hr.
178
2 3 5 10 20 30 50 100 200 300 500 700
Chip Cross Section, sq. mm.
0.5 0.7 0.6 0.9 0.8 1.0 2.0 3.0 4.0 5.0 6.0 8.0 10.0 20 30 40 50 60 80 100
F = 16 sq. mm.
4 5 10 20 30 40 50 100 200 300 500 1,000 2,000
Metal Removed, c.c. per min. 370
Brinell Hardness Number
100 150 200 250
Setting Angle 45 deg.
Hour Cutting Speed, meters per min.
60 50 40 30 20 15 10 9 8 7
Feed, mm. per rev.
Depth of cut, mm.
0.5 1 2 4 8 16
Transfer Lines
30 40 50 60 70 80 90 100
Tensile strength, kg. per sq. mm.

FIG. 4—Diagram for turning steel and steel castings. After Wallichs and Dabringhaus. The tool is high-speed steel on dry cut. For a setting angle of 30, 45, 60 and 90 deg., the correction factor $\gamma 60$ is 1.26, 1.00, 0.80 and 0.66 respectively.

angle of 45 deg. For tools with other setting angles, correction factors such as those given in Fig. 4 must be applied. The variation in the v_{60} value with the machining index is shown for one type of steel in Fig. 5.

With the aid of these diagrams and factors it is possible to solve the frequently puzzling problem of the correct cutting speed for a particular job, always bearing in mind that normally occurring variations will produce occasional anomalous results and that the methods are applicable to the machining of materials of comparable composition and structure. How then are the conditions to be varied when cutting a material that departs considerably from the normal, perhaps in hardness or in having a severe wearing effect on the tool?

the small feed, the edge of the tool should be carefully lapped. The cutting angle of the tool must be kept large, and to achieve this a reversed or negative top rake must be used so that the chips are heavily deformed. This change also adds to the mechanical strength of the point and enables the cutting edge to withstand the severe working conditions. The heating effect of the machining operation generally has no effect on the finished work for the zone of high temperature is very restricted and in addition any given part of the machined surface is exposed to the heating effect for a very short time.

Should the work consist of a material which, on account of some structural constituent, exerts a severe wearing effect on the tool, then the cutting speed must be con-

Apart from these modifications of general practice further problems arise when machining materials such as thin walled castings liable to contain hard spots. Such materials cause great trouble in the workshop, the chief difficulty arising from the spring of the tool when a hard spot is encountered, so that machining to fine tolerances is impracticable. No method of universal applicability can be given, but the use of a very heavy lathe and a strong tool of suitable shape can frequently save the rejection of the finished article.

Proper Tool Design

The design of tool profiles offers a very wide field for experiment. Fig. 6 shows the usual designations applied to the various angles and faces of a tool. (These terms are

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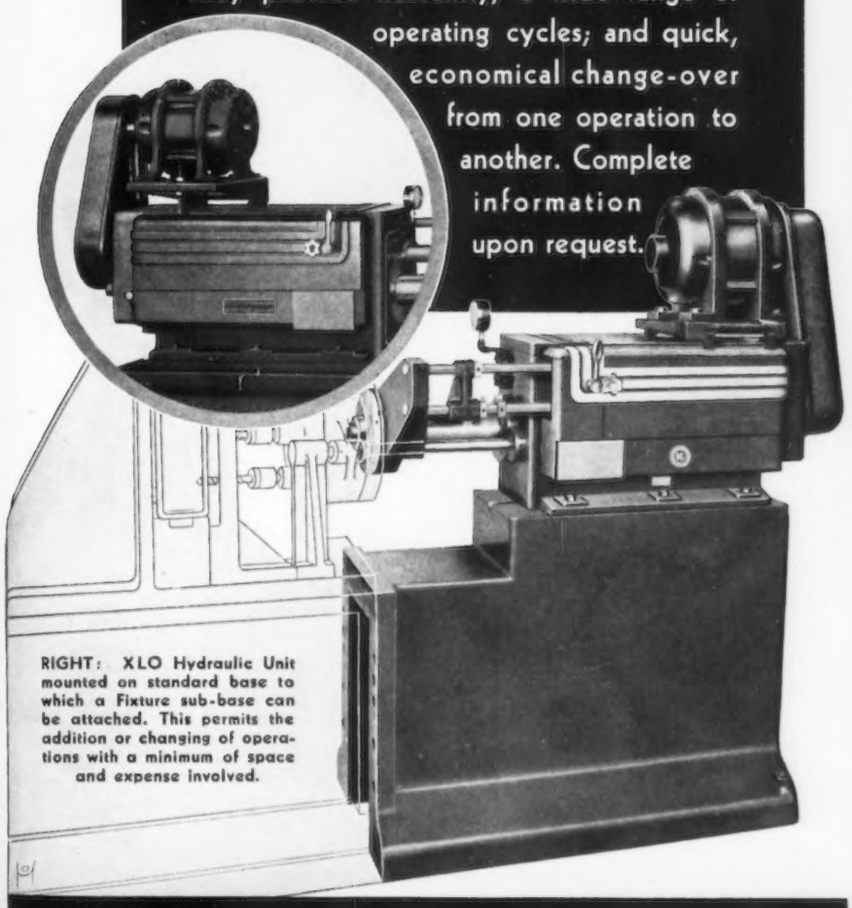

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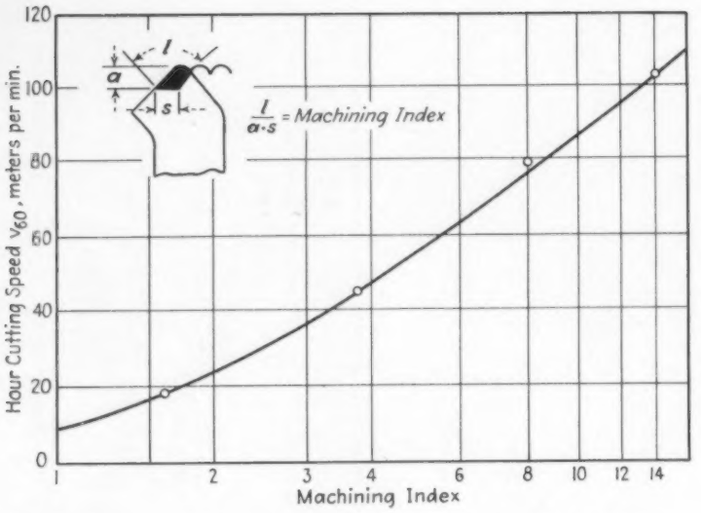

FIG. 5—Variation of hour cutting speed with machining index. After Leyensetter.

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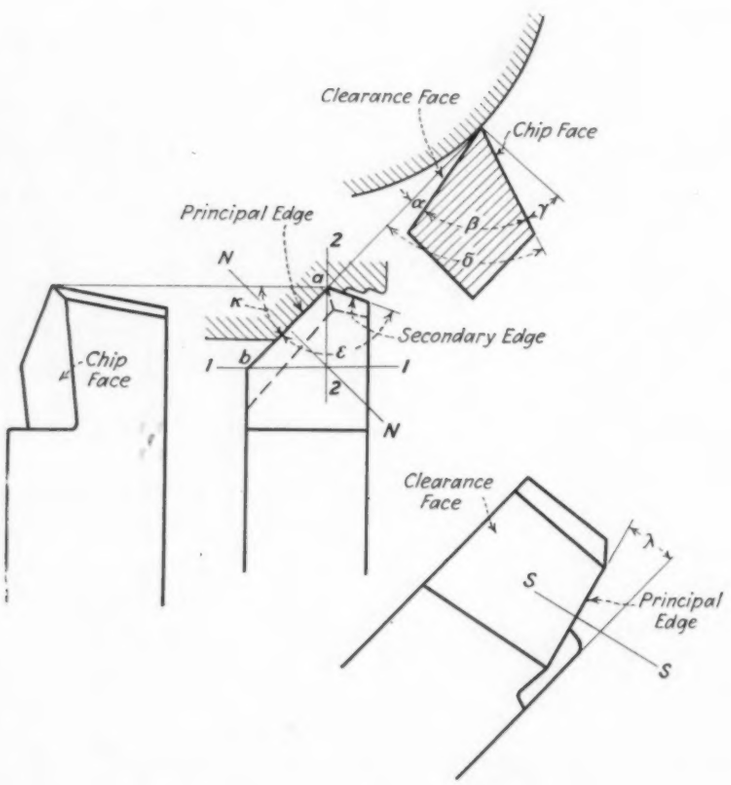


α = Clearance Angle
β = Wedge Angle
γ = Chip Angle
δ = Cutting Angle
ϵ = Nose Angle
κ = Setting Angle
λ = Edge Angle
r = Nose Radius
Plane N-N = Perpendicular to Principal Edge
Plane 1-1 = Parallel to Axis of Work
Plane 2-2 = Perpendicular to Axis of Work

FIG. 6—Standardized terms for cutting-tool design.

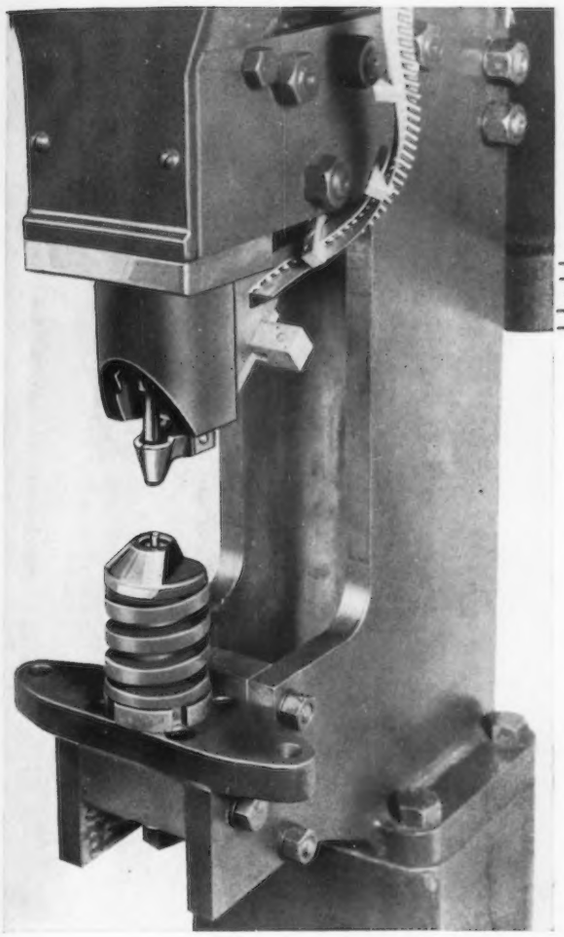
standardised in Germany, but a variable and frequently confusing nomenclature is common in England. The names given in this translation reflect as far as possible the German originals, due regard being paid to the English equivalent where one has been found.) Obviously, the range of choice in certain cases is restricted. The principal angles, α, β and γ are dependent on the nature of the material to be cut. Recommended values for these are known and have appeared as specifications in Germany (DIN 4951-4963, and AWF publications on carbide tools.[6]). The setting angle κ, the nose angle ϵ, and the nose radius r, are frequently settled by the shape required in the machined article, but in spite of these limitations, considerable advantages can accrue from a proper selection of those other dimensions that go to make up the complete tool profile.

The magnitude of the cutting pressure is approximately determined by the angle γ_N, that is, γ measured in the plane NN, and the direction of the thrust is also controlled by the same dimension. For closer examination of the influence of the various factors in the design of the tool the following equations may be used,[7]

$$\tan \gamma_1 = \tan \gamma_N \sin \kappa + \tan \lambda \cos \kappa$$
$$\tan \gamma_2 = \tan \gamma_N \cos \kappa - \tan \lambda \sin \kappa$$

From these it follows that when $\kappa = 90$ deg., $\gamma_1 = \gamma_N$, and $\gamma_2 = \lambda$ (side tool); and when $\kappa = 0$ deg., $\gamma_1 = \lambda$, and $\gamma_2 = \gamma_N$. The angles γ_1 and γ_2 are the components of γ_N measured in the planes 1-1 and 2-2 respectively. Furthermore, γ_2 determines that component of the cutting pressure tending to bend the work in the lathe, and therefore leading to chatter. With large positive values (sloping away from the work), the pressure is reduced, and, when turning slender work, γ_2 should be large and κ, γ_N, and λ should be chosen so as to give this result. In some cases the turnings may come off in a tangled mass, but this may be corrected by a slight step in the top surface of the tool that forces the turnings to curl off.

In turning brittle materials or where the tool is subjected to shock, it is advantageous to give λ as large a positive value as possible (positive values slope down towards the work); for this construction transmits the load on the



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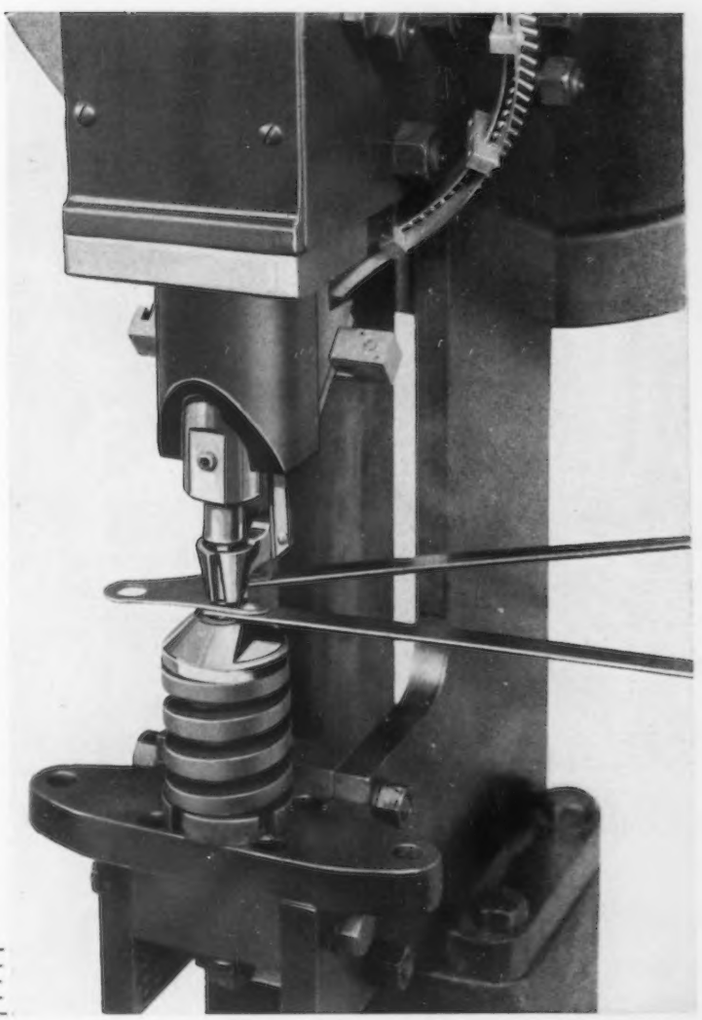

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cutting edge more readily into the shaft of the tool.

It is good practice to make the nose radius large in order to distribute the load on the edge of the tool. Too great a rounding of the tool point may lead to unsatisfactory chip removal, but where conditions permit, a general rule is to make "r" approximately 2.5 times as great as the feed.

The Tool Shaft

Any consideration of the relationship between tool design and cutting pressure leads to the question of a suitable choice for the dimensions of the tool shaft. An approximate calculation of the loads to which tools are subjected and the deflections that result from these loads leads to the conclusion that tool shafts are exceedingly highly stressed. In Fig. 3 it is shown that when turning a steel with a Brinell hardness number of 185 (tensile strength approximately 40 tons per sq. in.) a load of 200 kg. per sq. mm. is produced on the cutting edge, and, taking the chip cross section as 4 sq. mm. there is a total load of 800 kg. on the point of the tool. Considering the tool as a cantilever, with a projecting length equal to 1½ times the depth of the tool shaft—an approximation to ordinary conditions—it can be caluculated that bending stresses of the order of 10 kg. per sq. mm. (6.5 tons per sq. in.) are frequently produced at the point where the tool enters the holder. It may be said that such a stress is not excessive for steel of high speed or ordinary tool quality, but the figure mentioned is given only as an indication of the stresses developed in this way, and it may be considerably exceeded. In addition, in many modern tools, particularly of the carbide type, the shaft is of mild steel and has a recess at the end into which the carbide tip is brazed, and the change of section at this recess readily leads to overloading and permanent deformation especially under conditions of repeatedly applied stress.

These observations lead to the three following recommendations:

(1) The tool must project as little as possible from the holder. For efficient fixing it is essential that the base of the tool should be ground perfectly flat, but where this has not been done and the sole of the tool shaft does not make good contact with the holder at the point of emergence, a thin layer of soft packing, such as folded emery cloth should be inserted at his place.

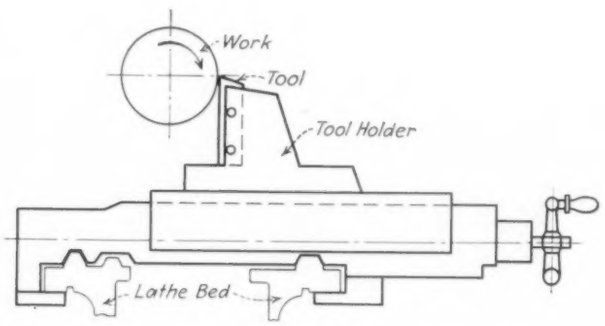

FIG. 7—Tangential tool holder of a design which obviates any bending of the tool.

(2) The shaft should be of high quality steel to avoid deformation. In tools with carbide inserts the yielding of the shaft frequently leads to cracking of the hard tip. The use of alloy steel shafts is not imperative and these also increase the difficulty of brazing on the carbide tip.

(3) The tool holder of the machine should be as firm as possible so as to form a good support for the shaft. The tool holders in most modern machines follow the same lines as those in lathes of the middle ages, and the design of a form of holder that would obviate any bending of the tool would appear to be a matter worth some study. Such a proposed design is shown in Fig. 7.

In a solid steel tool the position of maximum bending stress is where the tool enters the holder, but when carbide tools are being used care must be taken that the recess cut for the tip does not cause the maximum stress to fall at the reentrant angle so formed, particularly in view of the sensitivity of such a design towards fatigue cracking. For inserts of square side section, the side of the square should not exceed 0.45 of the thickness of the steel shaft, and where the length of the insert from back to front is 1.5 times the depth, the former dimension should not exceed 0.55 of the thickness of the shaft. Very long inserts should be avoided as the brazing operation easily leads to cracking of the tip from the thermal stresses set up.[8]

Care of Tools

Carefully designed tools require equally careful treatment in service if the best possible use is to be made of them. For high speed tools, assuming satisfactory heat treatment, probably the most important advice is to use only moderate pressure in grinding so as to avoid grinding cracks. Carbide tools must be handled with even more care. For proper grinding a carborundum wheel of the proper grade must be used and only a light pressure exerted, the operation being carried out either quite dry or with copious water cooling. A special warning must be given against cooling carbide tools by plunging them into cold water. The stresses set up by this maltreatment leads to cracks that may not appear until some time afterwards.

Even after fine grinding the edge of the tool is still irregular, and the clearance and chip faces are lightly scored. Only after lapping, generally on a diamond lapping wheel, do these parts become really smooth. On a properly lapped tool the turnings come away more smoothly, and, because of the better contact between the chips and top of the tool, the formation of a false cutting edge built up of small chip particles is facilitated.[9][10] Such a false edge results in a rough surface on the turned work. By the use of very high cutting speeds, which, for carbide tools may reach 250 to 500 ft. per min. depending on the metal cut, the tendency to form an accretionary edge disappears and, therefore, it is only at such high speeds that the advantages of lapped tools begin to appear. When machining hard steels that seldom

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form false edges on the tool at any speed, lapping should always be carried out.

In this connection it may be said that the advantages of carbide tools are appreciable only at cutting speeds. To use a carbide tool at a low cutting speed in the hope of obtaining an exceptional tool life is mistaken practice. The great wear resistance of carbide material exerts its beneficial effect at high cutting temperatures, and, at low temperatures, the amount of wear is proportionately greater. On this account, the cooling of carbide tools with a cutting compound does not have a pronounced effect as when high speed steel tools are used, and dry cutting with carbide tools is to be preferred. Many of the disappointments that followed the introduction of carbide tools were due to the entire neglect of the special properties of the new material.

A recommendation lately made,[11] particularly for the turning of soft metals, is to bevel the cutting edge of the tool slightly, the bevel angle being about half that of the chip angle and from 0.2 to 0.7 mm. wide, depending on the feed. This results in an increase in tool life because the accretionary edge built up under the cutting conditions finds a firm foundation on the bevel and is not situated on a sharp tool angle. The false edge is also more durable and breaks away less frequently with benefit to the quality of the surface on the work. With heavy feeds it is sufficient to round the edge of the tool to a radius of 0.1 to 0.2 mm. with a few light strokes of a hone. This smooths the edge and improves the mechanical strength of the tool.

A steel tool should be reground only when complete blunting, resulting in burnishing instead of cutting of the work, has occurred. With carbide tools, on the other hand, resharpening is called for after very slight blunting. In such circumstances regrinding is cheaply and easily carried out, and the whole of the tip can be used up without waste. The overworking of carbide tools without regrinding may lead to fracture of the tip.

The care of tools should extend even to their storage, which should be designed to prevent the cutting edges coming into contact with any material likely to cause damage; for a rough edge to a tool always results in inferior work. Small tools should be stored in wooden racks and large ones kept in wood or cardboard containers. Valuable tools, tipped with carbide, should be distinctively marked with a painted line down the shaft so that the machinist can give them the attention they deserve.

Cooling and Lubrication

In recent years the advantages resulting from the use of cooling and lubricating agents during machining have been fully brought out,[12][13] so that only a brief mention of them will be made here, and attention will be confined to elucidating the action of such media in improving machining processes.

The most obvious action of liquid compounds is the rapid removal of the heat generated at the cutting edges. Since the heat conductivity

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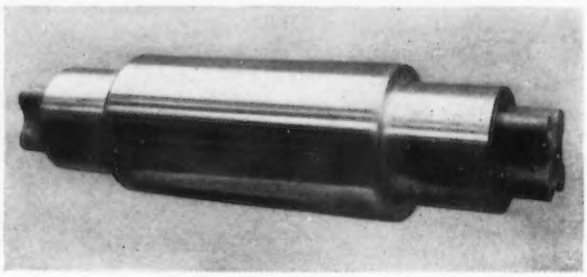

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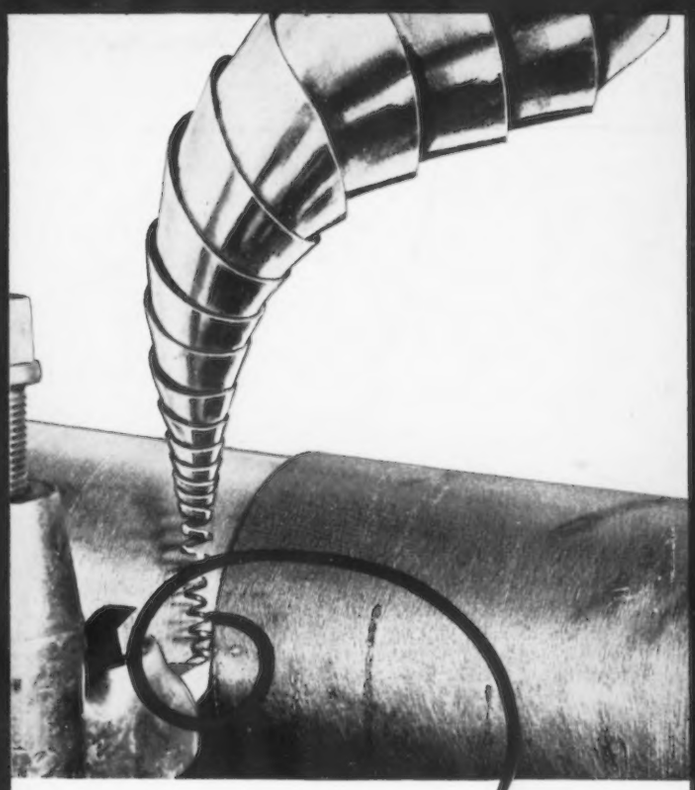

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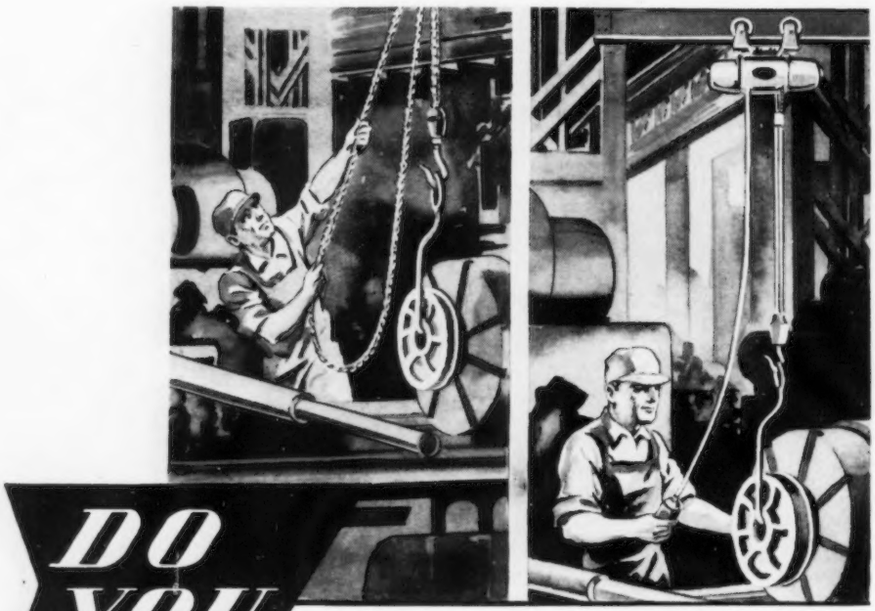
and specific heat of these compounds, particularly the oils, are limited, the improvement in tool life obtained by the use of such media cannot be due entirely to their cooling action. It has been shown by Gottwein that the reduction in cutting temperatures consequent on the use of cutting fluids is only of the order of 10 to 30 C. deg. The marked improvement brought about by coolants can probably better be explained by a comparison with some of the known facts concerning metallic wear.

It has been shown in various researches that a process of oxidation is bound up with the action of metallic wear, and that wear may be considerably diminished by excluding oxygen from the rubbing surfaces. Such an effect is probably exerted by a stream of cooling liquid in metal working, but only if the coolant spreads completely over the cutting edges of the tool and thereby excludes atmospheric action. A spray or a drip feed of cooling compounds cannot achieve this desirable result.

To ensure the flooding of the cutting edge with an unbroken flow of liquid the so-called "pressureless" feed is most effective. Such a system is governed by an overflow arrangement and the liquid flows under a very small head, in a stream of low velocity over the tool point.

Apart from the influence on the actual process of machining, the use of cutting media also influences the nature of the machined surfaces[11]. To sum up the fact so far demonstrated it may be said that to obtain a smooth surface on the work a cutting compound of the water dispersion type should be used, and the clearance face of the tool highly polished, but under these conditions the life of the tool will be short. When a long tool life is sought, a cutting oil should be used, but with such a medium the machined surface will not attain the finish produced by the former method of working.



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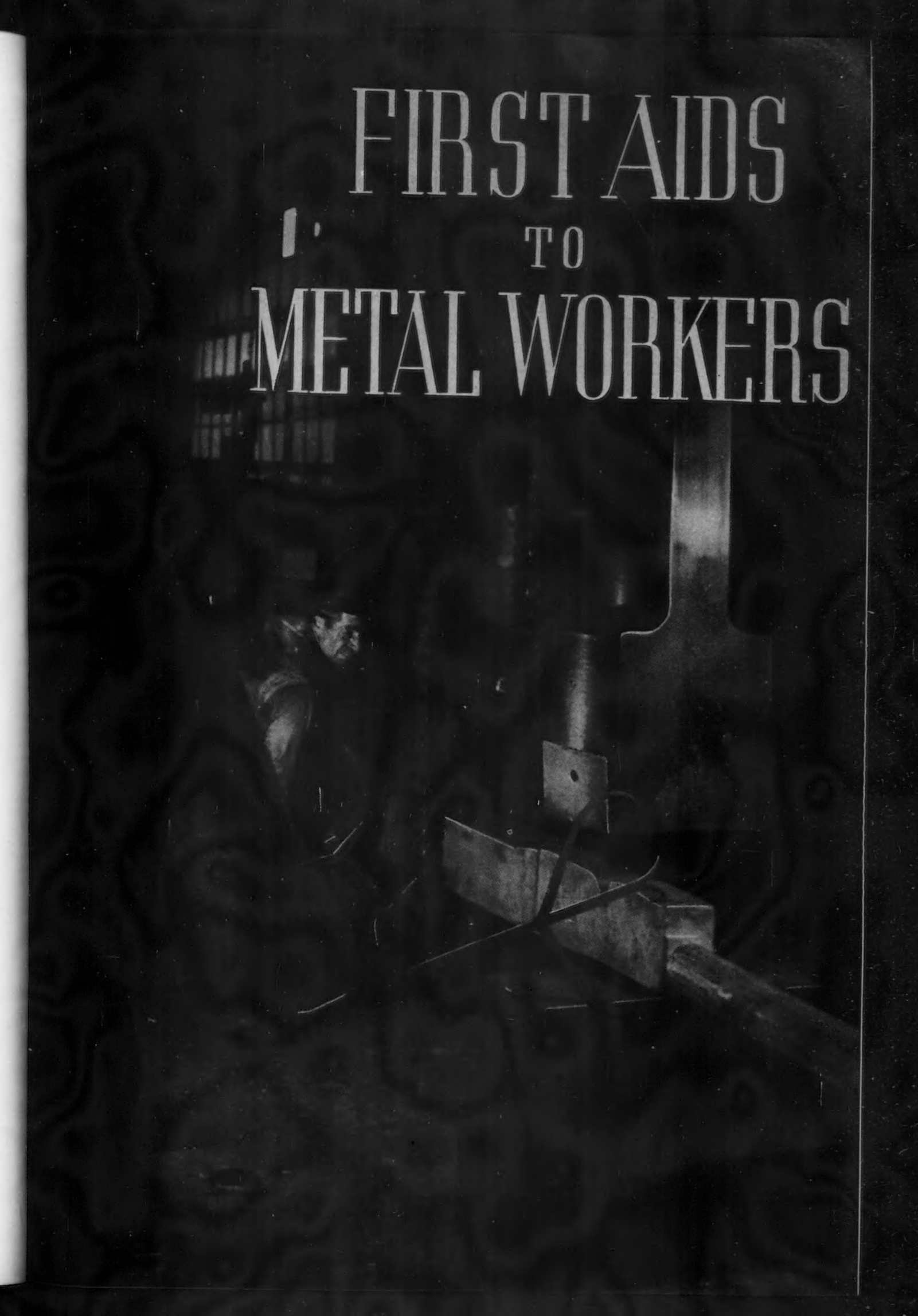
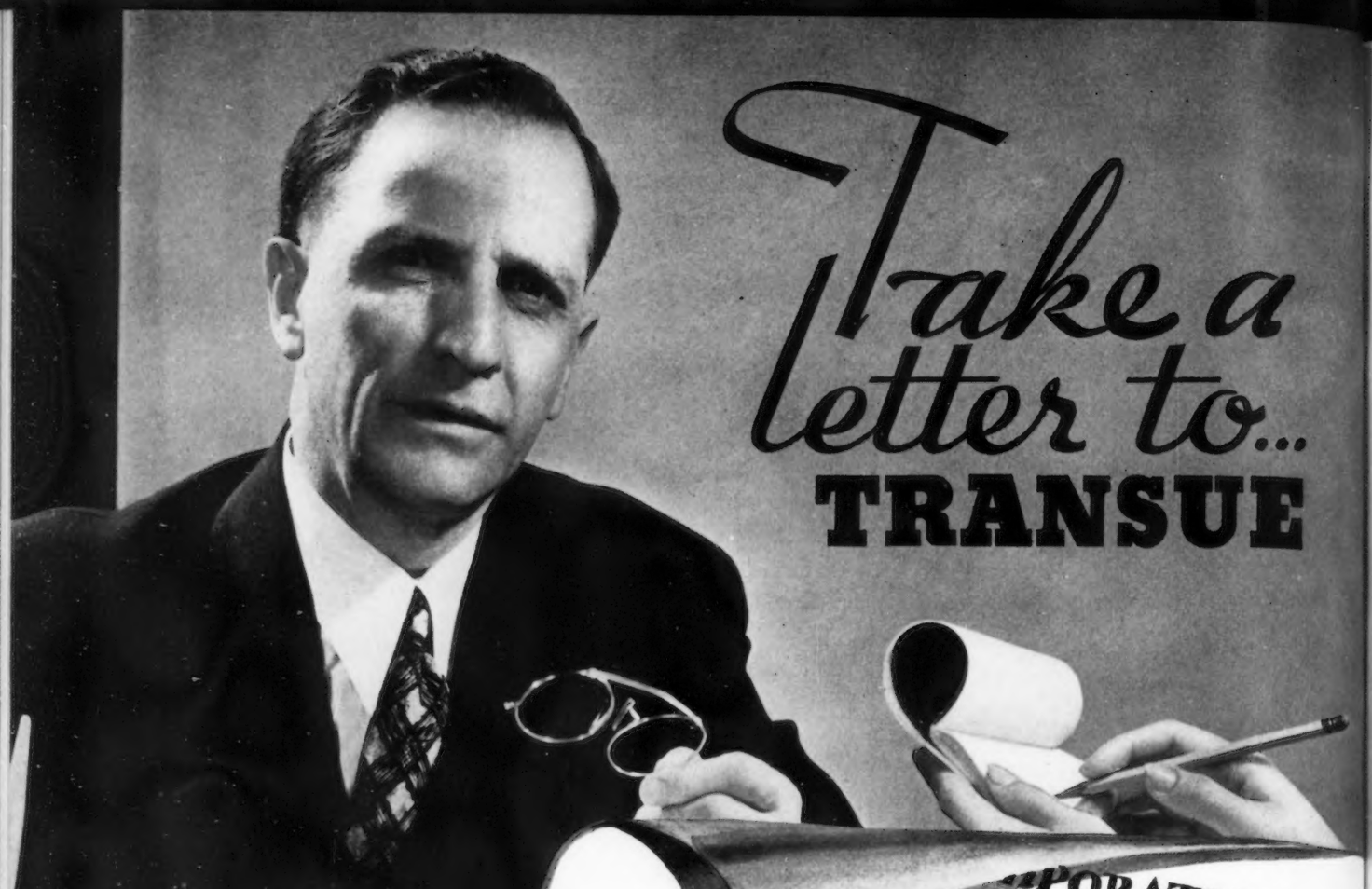
FIRST AIDS TO METAL WORKERS





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TIPS for the METAL WORKER

DESCRIBED herein is an electrical process whereby an auto-body maker secures differential hardness in his product, and, also, mention is made of K-Seal, a protective coating to facilitate differential carburizing.

A new copper paint has been developed to protect metal surfaces, a recently-developed flux and solder for aluminum, cast iron, etc., is now being marketed, and a producer of steel cleaners is offering orthosilicate, a new efficient salt for cleaning steel.

A simple bath devised in England for cooling parts for shrink fitting is shown, and mention is made of how one plant utilizes odd-shape bar ends and how another manufacturer handles his forgings automatically.

◇ ◇ ◇

Localized Heat Treatment

A MANUFACTURING plant catering to the automotive industry employs a clever electrical device for differential heat treatment of car parts. The equipment has two (or more) electrical contacts which are clamped onto the steel product and thereby direct current through certain known sections. If this current is large enough, the steel product will be heated very high in certain sections, but will remain temporarily unchanged in other areas.

This particular plant handles a number of carburized and quenched steel car parts, and, for best operating results, these parts require a soft and ductile center and/or other areas which should be tough rather than hard and brittle. To obtain this condition, a hardened car part is placed in the machine and the clamps are so placed that the areas to be softened are heated and normalized by the passage of the electrical current—the remainder of the piece remains at its original hardness. The entire operation is carried out automatically on production work and requires only a short time interval.

Conversely, the same machine can be used to harden certain areas of a soft steel part. The passage of the electrical current heats specific sections, but other sections remain unheated—when the entire piece is quenched the heated portions will harden with quite sharp lines of demarkation from the original soft sections.

Shrink Fitting

Shrink fitting, as normally practiced by heating one part, is an operation well known for many years by workshop engineers. This procedure, however, is obviously limited to components which can be conveniently handled when hot, or which can be heated without risk of damage or distortion.

The reversal of this normal procedure, whereby the inner member is cooled and contracted by contact with solid carbon dioxide, has been used to an increasing extent over the past few years. Whereas originally the dry ice shrinking procedure was confined to larger manufacturing concerns, there has latterly been a tendency for smaller shops to adopt the process. For this reason the following description of a special shrinking bath has

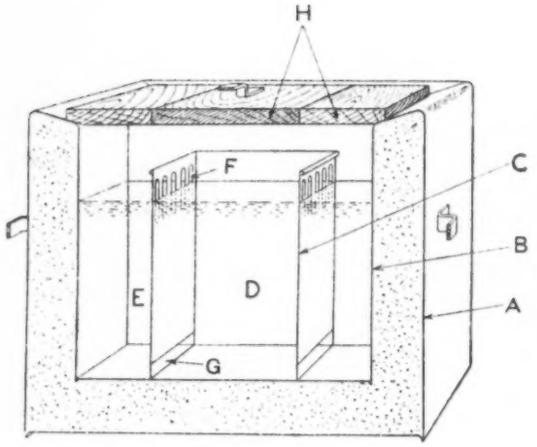

FIG. 1—A bath for use with dry ice in the production of shrink fits. The insulating outer shell (A) protects the tank (B). A removable partition (C) separates the bath (D), into which parts are dipped, from the compartment (E) which holds the dry ice. Slots are provided at (F) and (G), through which fluid circulates.

been prepared by Imperial Chemical Industries, Ltd. It will be noticed in Fig. 1 that the dry ice cools a special low-freezing noncorrosive liquid. The parts to be shrunk are immersed in this liquid.

Solid carbon dioxide has a temperature of —100 deg. F., and, assuming that the normal workshop has an atmosphere near 50 deg. F., it is apparent that parts can be cooled through a range of 150 deg. To give an idea of the shrinking effect made possible by the process, this temperature differential will produce a contraction in mild steel and cast iron of about 0.0009 in. per in. of diameter. The contraction of aluminum and brass is appreciably greater under the same conditions.

The equipment sketched in Fig. 1 has a bath holding 8 gal. of fluid, for the cooling of which 15 to 20 lb. of dry ice is required, with an addition of 2 lb. per hr. to maintain the low temperature. For steel and cast iron the rate of consumption of dry ice is ⅛ lb. per lb.; consumption is 1/10 lb. per lb. for brass.

A good dry ice fit compares favorably with a press-on fit. The extreme coldness does not embrittle the great range of industrial metals and alloys. This procedure is currently being used to fit cylinder liners in automobile motors, fitting of bushes in machine tools and the assembly of large cast iron couplings on shafts.

Forgings Handled Automatically

In many forging plants the excessive handling and rehandling of work is a sizable expense item. To reduce such costs to a minimum, one large maker has evolved an ingenious handling method. Running from each hammer is a chute which directs completed forgings to a conveyer belt. This belt in turn carries the forgings up to a point where they can drop into one of a number of baskets which are moving around the shop on an endless trolley. As these baskets encircle the shop they are filled with forgings from all the hammers in the same manner, and, at one point, each basket dumps its load into a storage hopper. When a tumbling barrel is ready for a load, forgings are released from the storage hopper. With an arrangement like this there is a minimum handling of forgings, for, from the time they leave the hammer, their journey is entirely automatic up to the time they drop into the tumbling barrel to be cleaned.

Corrosion Prevention

Pure metallic copper of extreme fineness and of the irregular flaky structure known as "dendritic" can now be applied to iron, steel, wood, concrete or other surfaces which require a protective coating of unusual effectiveness. This new coating is being produced under the name of Coppercote and is sold by American Coppercote, Inc., 480 Lexington Avenue, New York.

The product involves a special vehicle in which minute flakes of pure metallic copper remain in perfect suspension. While the coating is applied, a physico-chemical reaction occurs between the particles of copper and its vehicle. Since the copper is "dendritic" in structure rather than granular, a closely knit coating results, which, when set, forms a tough metallic surface. When applied to a surface of ferrous metal it is said to positively prevent corrosion. The manufacturers also claim that when it is applied to a surface already rusted, further corrosive action will be arrested. Tests so far made would indicate that Coppercote will not crack, scale or chip as the result of extreme temperature changes, nor is it affected by the ultra-violet rays of the sun.

A turbulent action which takes place when Coppercote is applied causes it to spread itself automatically and to work its way into every pore of the coated surface to which it becomes thoroughly united. The copper particles combine and adhere closely to the base while the vehicle rises and forms a second protective film. This phenomenon permits the use of various colors in the vehicle.

Coppercote has been applied to steel columns under conditions of extreme dampness in the Eighth Avenue subway, New York, and, after a year of service, there has been no deterioration. A test recently completed on a railroad car subject to severe corrosive conditions is shown in Fig. 2. An experiment recently reported by a representative of the Department of Public Works of a Canadian Province has shown also that Coppercote gives excellent protection for wood.

Scrap is Saved

Waste of material is a problem faced by many manufacturers. One maker of gears has hit upon a practice which practically eliminates scrap on bar ends and thus cuts down production costs. When making blanks with a set thickness and width, the operator of the bar cut-off machine continues to the end of a bar. Even though the blank from the end of the bar is not of the desired width it is pressed to the same thickness. These end-of-bar blanks are segregated and stocked. Subsequent orders often specify a thickness and width which may be taken from this stock pile. Thus material pressed from bar ends on one order need not be scrapped as it can be used in many cases to fill other orders. A potential loss is in this manner converted into an asset.

Flux for Aluminum, Cast Iron, Etc.

An item which should be of considerable interest to metal workers everywhere is the new flux developed by Alumaweld Co. of America, 2442 South Parkway, Chicago. This new flux used in conjunction with a special high tensile solder is said to do a joining job

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heretofore considered almost impossible.

The Alumaweld flux and solder is applied with an ordinary soldering iron or blow torch. The soldering job is done at a low temperature, but has the advantage of requiring high temperatures to melt it the second time. It is said to work equally well on aluminum, stainless steel, die cast pot metal, cast iron, copper, brass, etc., which makes it easy to join any two of these metals if such is desired.

Alumaweld solder has a tensile strength of 12,000 lb. per sq. in. The finished joint can be worked or machined and takes a polish over which chromium or any other plating can be applied.

Differential Carburizing

K-Seal, a product of the Lindberg Engineering Co. laboratory, offers important advantages in steel treating operations where it is necessary to limit carburizing to certain areas.

K-Seal is supplied in the form of a powder and a liquid which are mixed in definite proportions as used. This protective coating will entirely prevent the penetration of carbon in the carburizing treatment.

It adheres firmly to the steel surface, so that very sharp boundaries can be obtained between the areas of full penetration and the painted surfaces which show a total absence of carbon.

Orthosilicate for Cleaning Steel

The place of alkaline salts in the cleaning of steel prior to tinning, electroplating, vitreous enameling, and painting has long been recognized. Caustic soda, trisodium phosphate, soda ash (sodium carbonate), modified soda (a mixture of sodium carbonate and sodium bicarbonate), and causticized ash (a mixture of caustic soda and soda ash) were originally used for this purpose.

Later it was found that solutions of certain sodium silicates were excellent cleaners for steel. Commercial hydrated sodium metasilicate and commercial hydrated sodium sesquisilicate were produced and made available to the metal cleaning industry.

These two chemicals, particularly the metasilicate, are valuable in the cleaning of soft metals such as tin and aluminum. However, it has been recognized for some time that if the orthosilicate could be produced it would probably be considerably more efficient than the other two salts for the cleaning of steel. The difficulty had been to manufacture sodium orthosilicate at low cost in a convenient form. Within the last few months this objective has been attained by Pennsylvania Salt Mfg. Co., and anhydrous sodium orthosilicate is now being commercially marketed as dry, white, free-flowing granules readily soluble in water. The material contains 62.5 per cent sodium oxide, approximately 95 per cent of which is available for detergent purposes in concentrations usual in steel cleaning.

This new heavy chemical has the excellent penetrating, wetting, and emulsifying power typical of all the silicates. Some points of superiority over other sodium silicates which are claimed for anhydrous sodium orthosilicate are as follows: The action is very fast; the "lasting power" is three times that of commercial hydrated sodium metasilicate, one and three quarters times that of commercial hydrated sesquisilicate, three and one half times that of soda ash, and seven times that of trisodium phosphate; the electrical conductivity is very high; and the solution is readily rinsed from steel.

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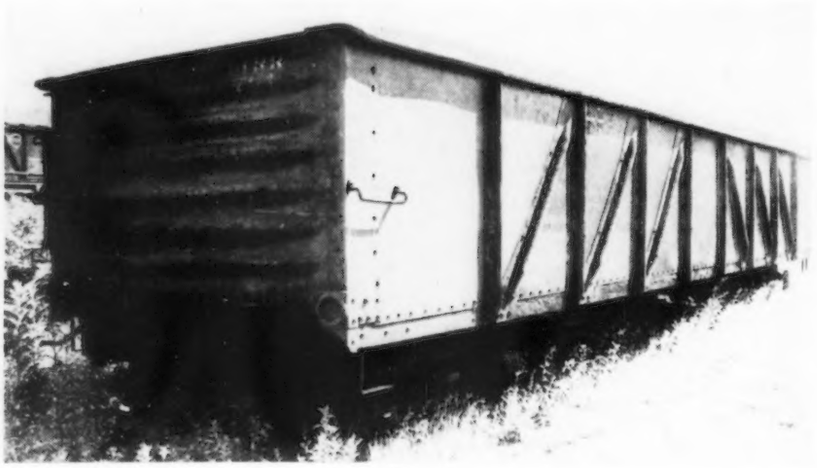

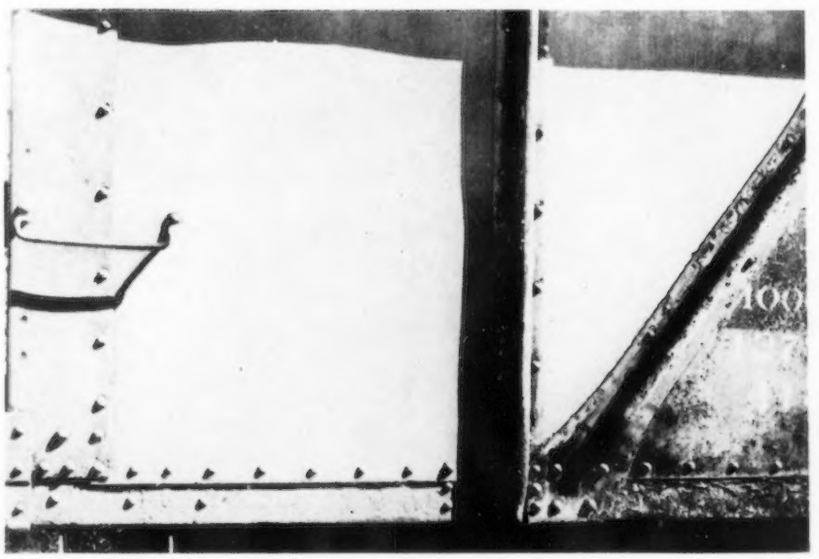

FIG. 2—A badly rusted gondola car had two end panels treated with Coppercote after the scale and rust had been chipped off. The top view shows the start of the test, and the bottom view shows the condition of the panels 15 months later. Note that there is no indication of rust breaking through the coating even after this long exposure to the sun's rays, ocean fogs and winter storms.

Machine Tool Builders Hold 35th Annual Convention

CLAYTON R. BURT, president, Niles-Bement-Pond Co., Hartford, and 35th president of the N.M.T.B.A.

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THE increasing importance of depreciation; security versus opportunity in business and employment; public credit and public finance; foreign affairs as affecting the outlook for machine tool sales; and motor and other technical standards were topics covered by the various speakers at the 35th annual convention of the National Machine Tool Builders Association, held at The Homestead, Hot Springs, Va., Oct. 5-7.

A program of sports included a golf tournament and a skeet contest, and prominent on the social program was the 35th anniversary banquet, with H. W. Dunbar, vice-president of the association, as master of ceremonies.

As reported in THE IRON AGE of Oct. 8, page 103C, election of officers resulted in the naming of Clayton R. Burt, president; H. W. Dunbar, first vice-president; N. A. Woodworth, second vice-president; and H. C. Pierle, treasurer. H. H. Lind is general manager and Mrs. Frida F. Selbert is secretary of the association.

Depreciation Problem Has Added Significance

Manufacturers are finding that they must do something about the depreciation problem if they wish to pay only their fair share of Federal taxes, said P. T. Norton, Jr., professor industrial engineering, Virginia Polytechnic Institute, Blacksburg, Va., in a paper on "Depreciation—Its Increasing Importance."

In addition to showing why it is essential under present laws that depreciation charges should be adequate, Professor Norton showed that the problem is much more important to makers of machine tools and other durable goods than to manufacturers of consumer goods.

"This is true," he said, "because machine tool builders are not only interested in the depreciation charges of their own assets, but also to a much greater extent in the depreciation charges which their customers will make on the machine tools which these customers use in their own factories. I am convinced that the rate at which machine tools will be replaced five to 10 years from now will depend to a considerable extent on the depreciation rates which are used during the next few years. If depreciation charges are inadequate during the next few years it will be much more difficult to sell machine tools to replace those which are really obsolete. Machine tool manufacturers must interest themselves in the depreciation charges made by their customers, otherwise the pressure exerted by the Federal government may reduce depreciation rates and charges to the point that desirable replacements may not be made simply because the difference between book value and realizable value is so great that management will not, or in some cases cannot, write off these differences on the books."

In discussing the tax aspects of depreciation, Professor Norton emphasized the fact that the recent changes in tax laws and regulations, while very important, have in practically every case an indirect rather than a direct effect on depreciation.

"In some cases no direct reference to depreciation is made, although the effect on the depreciation problem is very great. I would suggest that every manufacturer might well have those persons who handle his tax matters make a careful study of the whole depreciation problem as it affects his company, so as to be sure that consideration is given both to the direct and indirect effects of these recent changes. I also believe that the matter is serious enough to justify the head of the company in giving it his own personal attention."

Professor Norton's paper was discussed by E. C. Clarke, president, Chambersburg Engineering Co., and by others at the session.

At the conclusion of the discussion it was voted to appoint a new cost committee to cooperate with the Machinery and Allied Products Institute in establishing a sound depreciation policy.

Against Changes in Monetary Value

Basic ideas that affect public credit and public finance were set forth in an outstanding address by James R. Garfield, Cleveland, counsel for the National Machine Tool Builders Association, who warned against changes in basic standards, including the gold content of the dollar. With credit depending upon the honest meeting of our obligations, quick return should be made to established standards of value. Extension of our credit beyond the ability to pay from year to year can reach but one end—disaster, he pointed out. Inflation brings disaster and in this the wage earner is the one who throughout history has suffered most.

Erwin Schell, professor and head of department of business administration, Massachusetts Institute of Technology, in an address on "Security vs. Opportunity in Business and Employment," emphasized machinery as a national resource of the second degree. Continuity is the basic aim of industry, he said, and to assure continuity machine tool builders should concentrate on future opportunities. They should invest heavily in good will, orient themselves for future changes and be alert for new ideas. Opportunities include designing of machines for mobility, and recognizing in the design of controls, etc., that an operator has two hands instead of "just one right hand." Machines should be clean to operate, dirt and grime no longer being a necessary partner of toil, thus dignifying the operation of machines. Design of machines of different makes for use in integrated production groups was also stressed as a future opportunity.

Standards Beneficial

In an address on "Motor Standards," J. L. Hamilton, Century Electric Co., St. Louis, and chairman of the motor and generator section of the National Electrical Manufacturers Association, outlined the economic background of both the electrical and machine tool industries and discussed a number of common interests, with particular reference to standardization. More than $5,000,000 has been spent in the standardization of motor frame dimensions, he said. Active cooperation, he emphasized, would be a benefit to both industries and to the users of the products of both industries.

H. W. DUNBAR, manager grinding machine division, Norton Co., Worcester, and first vice-president of the N.M.T.B.A.

N. A. WOODWORTH, president, Ex-Cell-O Aircraft & Tool Corp., Detroit, and second vice-president of the N.M.T.B.A.

H. C. PIERLE, secretary and sales manager, R. K. LeBlond Machine Tool Co., Cincinnati, and treasurer of the N.M.T.B.A.

F. O. Hoagland, master mechanic, Pratt & Whitney Co., and chairman of the association's standards committee enumerated in an interesting manner the various A.S.A. standards useful to members of the association. He also outlined the A.S.A. standardization projects now in process, including a standard relating to surface finishes, The association is to have representation on the Sectional Committee on Petroleum Products.

Promoting Railroad Sales

In his report to the association, H. H. Lind, general manager, covered a number of topics of timely interest. He advocated promotion of machine tool sales to railroads. "A number of conditions cause me to believe that it is time to cultivate the railroad business," he said. "First, shop men fully realize the conditions of their equipment and executives are becoming conscious of the cost of obsolete equipment. Second, railroad executives have seen the results of modernization in cars and new equipment. Third, the revenue of most roads has improved substantially. Fourth, competitive operating conditions make it necessary for railroads to plan economies."

Discussion of the Walsh-Healy Government Contracts Act, the Robinson-Patman Act, the Social Security Act, and the Revenue Act of 1936, was also an interesting part of Mr. Lind's address.

FTC Sues, Alleging Collusive Bidding

A COMPLAINT alleging collusive bidding and fixing and maintenance of uniform prices, in violation of section 5 of the Federal Trade Commission Act, has been issued by that commission against nine companies engaged in the manufacture and sale of turbine-generators and condensers. The Heat Exchange Institute, a trade association with headquarters in New York, also is a respondent. The respondent companies are:

General Electric Co., manufacturing turbine-generators; Westinghouse Electric & Mfg. Co., Allis-Chalmers Mfg. Co., and Elliott Co., manufacturing both turbine-generators and condensers; Worthington Pump & Machinery Corp., Harrison, N. J.; Ingersoll-Rand Co., Foster-Wheeler Corp., C. H. Wheeler Mfg. Co., Philadelphia, and Ross Heater & Mfg. Co., Buffalo, dealing only in condensers.

Steel Exports Slightly Lower—Imports Up 26 Per Cent

IRON and steel exports in August declined to 295,341 tons from 296,738 tons in July. In dollar volume, however, the drop amounted to 8.2 per cent, or from $9,624,556 to $8,837,538. Exports of scrap rose slightly to 194,600 tons from 192,817 in July. Among the items showing substantial losses were black steel sheets, and ingots, blooms and sheet bars. Steel rail exports rose from 5207 tons in July to 12,126 tons in August.

Total exports for the eight months ended August were 2,223,670 tons, with a value of $72,953,525, compared with 2,136,781 tons in the corresponding period last year, valued at $58,593,554.

Imports of iron and steel products rose over 26 per cent, from 47,940 tons in July to 60,697 tons in August. Increases were registered in almost all classifications, structural shapes showing the greatest gain. For the eight-month period this year, imports rose 73 per cent over the same period last year, large gains occurring in pig iron and scrap.

Imports (In Gross Tons)

	August		Eight Months Ended August	
	1936	1935	1936	1935
Pig iron	12,524	8,568	122,527	67,573
Sponge iron	....	151	1,380	817
Ferromanganese[1]	1,942	2,382	15,345	30,872
Spiegeleisen	5,249	....	26,634	....
Ferrochrome[2]	18	....	21	1
Ferrosilicon[3]	21	50	446	517
Other ferroalloys[4]	....	....	426	1
Scrap	12,518	2,376	88,207	16,016
Pig iron, ferroalloys and scrap	*32,272*	*13,527*	*254,986*	*115,797*
Steel ingots, blooms, etc.	8	194	69	1,261
Billets, whether solid or hollow[5]	125	....	533	....
Wire rods	1,722	801	12,772	8,912
Semi-finished steel	*1,855*	*995*	*13,374*	*10,173*
Concrete reinforcement bars	1,012	481	3,085	2,010
Hollow steel bars	196	110	1,345	683
Merchant steel bars	3,557	2,422	24,652	15,613
Iron slabs	....	....	....	....
Iron bars	98	228	872	1,146
Boiler and other plate	150	141	202	387
Sheets, skelp and saw plate	2,062	670	13,918	5,333
Die blocks or blanks, etc.[5]	42	....	155	....
Tin plate	....	32	140	138
Structural shapes	7,264	4,521	35,924	25,124
Sheet piling	81	....	2,151	....
Rails and track material	542	458	4,947	2,921
Welded pipe	546	293	3,755	1,700
Other pipe	3,384	610	13,981	10,503
Hoops and bands for baling	601	1,000	1,466	4,954
Other hoops and bands	2,683	2,079	15,599	14,443
Barbed wire	1,028	1,656	11,206	16,402
Round iron and steel wire	530	251	3,330	2,659
Telegraph and telephone wire	1	1	35	21
Flat wire and steel strips	283	249	1,933	1,117
Wire rope and strand	171	156	1,620	1,214
Other wire	180	127	1,007	751
Nails, tacks and staples	1,818	2,112	16,280	12,445
Bolts, nuts and rivets	94	1	386	227
Horse and mule shoes	28	64	259	445
Rolled and finished steel	*26,361*	*17,662*	*158,248*	*120,236*
Malleable iron pipe fittings	23	....	93	46
Cast iron pipe and fittings	59	....	298	27
Castings and forgings	127	128	783	790
Total	60,697	32,312	427,782	247,069

[1] Manganese Content. [2] Chrome Content. [3] Silicon Content. [4] Alloy Content. [5] New classes. No comparable figures for previous year.

Exports (In Gross Tons)

	August		Eight Months Ended August	
	1936	1935	1936	1935
Pig iron	320	570	1,369	2,113
Ferromanganese and spiegeleisen	44	2	318	41
Other ferroalloys[5]	668	....	1,816	....
Iron and steel scrap	194,600	156,685	1,437,690	1,481,126
Tin plate scrap	1,082	2,779	11,102	24,903
Waste-waste tin plate	3,967	1,417	25,597	15,161
Pig iron, ferroalloys and scrap	*200,681*	*161,453*	*1,477,892*	*1,523,344*
Ingots, blooms, billets, sheet bars	1,303	3,657	12,401	33,655
Skelp	5,675	12,117	27,456	29,383
Wire rods	2,533	2,692	25,596	16,678
Semi-finished steel	*9,511*	*18,466*	*65,453*	*79,716*
Bars, concrete reinforcement[5]	562	....	2,374	....
Bars, other steel	4,169	3,736	32,534	36,978
Iron bars	34	52	788	710
Plates, iron and steel	7,542	3,706	46,045	26,484
Sheets, galvanized steel	4,072	5,059	36,273	50,160
Sheets, galvanized iron	211	110	1,061	1,176
Sheets, black steel	7,115	7,840	88,990	68,716
Sheets, black iron	738	403	5,169	3,615
Hoops, bands, strip steel	4,906	3,856	40,343	28,815
Tin plate and taggers' tin	14,641	12,431	162,357	76,182
Terne plate (including long terne)	77	148	2,478	1,551
Structural shapes, plain material	5,226	2,767	36,443	20,645
Structural material, fabricated	959	983	11,354	15,328
Sheet piling	146	....	1,745	....
Tanks, steel	1,939	611	15,990	4,307
Steel rails	12,126	7,995	51,390	34,778
Rail fastenings, switches, spikes, etc.	1,853	803	8,560	6,557
Boiler tubes	784	667	4,452	5,922
Casing and oil line pipe	3,033	1,470	16,046	20,781
Pipe, black and galvanized, welded steel	1,414	2,154	13,159	23,944
Pipe, black and galvanized, welded iron	239	231	2,511	2,210
Plain wire	3,264	3,900	29,594	25,129
Barbed wire and woven wire fencing	2,576	2,801	21,888	22,284
Wire cloth and screening	65	96	705	710
Wire rope	151	260	2,126	2,797
Wire nails	431	962	5,205	7,110
Other nails and tacks	323	399	2,189	2,493
Other wire and manufactures	444	399	3,258	3,480
Bolts, nuts, rivets and washers, except track	492	469	4,080	4,275
Other finished steel	85	192	1,423	985
Rolled and finished steel	*79,617*	*64,400*	*650,530*	*498,122*
Cast iron pipe and fittings	3,546	1,192	13,091	9,451
Malleable iron screwed fittings	232	491	2,152	2,330
Carwheels and axles	687	285	4,867	12,120
Iron castings	651	499	4,903	6,234
Steel castings	241	209	2,064	1,837
Forgings	175	317	2,718	3,627
Castings and forgings	*5,532*	*2,993*	*29,795*	*35,599*
Total	295,341	247,312	2,223,670	2,136,781

August Imports of Pig Iron by Countries of Origin

(In Gross Tons)

	August		Eight Months Ended August	
	1936	1935	1936	1935
United Kingdom	60	160	4,846	12,659
British India	5,038	4,504	39,120	19,256
Germany	60	225	3,879	375
Netherlands	5,837	126	47,857	19,167
Canada	692	2,953	9,392	9,005
France	....	....	....	50
Belgium	444	....	973	100
Norway	393	....	2,072	1,787
Sweden	....	100	374	647
Russia	....	500	13,605	3,673
All Others	....	....	409	854
Total	12,524	8,568	122,527	67,573

August Imports of Iron and Manganese Ores

(In Gross Tons)

	Iron Ore		Manganese Concentrates, 35 Per Cent or Over	
	1936	1935	1936	1935
Canada	15,017	7,204	....	102
Cuba	44,500	11,000	....	....
Chile	108,900	66,400	....	52
Spain	....	100	....	....
Norway	15,002	....	....	....
Sweden	32,852	7,029	....	....
French Africa	....	....	....	....
Russia	....	8,300	....	4,587
India	....	....	10,387	4,907
Brazil	1	....	4,543	446
Gold Coast	....	....	21,208	3,626
Other Countries	17,359*	8,655	....	17
Total	233,631	108,688	36,138	13,737

*Includes 17,153 tons from Australia.

THIS WEEK ON THE ASSEMBLY LINE

. . . Auto production jumps up as Pontiac joins other General Motors units in production.

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. . . Packard and Studebaker sales for September bear out sales executives' predictions of an extremely active fall market for motor cars.

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. . . Both Chevrolet and Ford production schedules are set high for the next two months.

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. . . The American Bantam car, a resuscitated Austin, gets into production on eight models with a bank of 20,000 dealer orders.

"Season of mists and mellow fruitfulness,
Close bosom friend to the maturing sun."

SO John Keats describes this time of the year in his "Ode to Autumn." For Detroit, the mellow fruitfulness is blossoming out in the form of gorgeous private displays of new models. To this harvest festival have been trooping trainloads of dealers and distributers from all over the country. Starting in with Packard's preview which brought 4000 dealers into the city, there has been a constant procession coming into town, overflowing the hotels and eating places and making it hard for the non-automotive visitor to find a place to lay his head at night. The showmanship displayed at these dealer meetings is top-notch and all the automobile companies have put themselves to considerable expense to see that the dealer goes home with proper enthusiasm to sell his product.

Increasingly important in this scheme of sales promotion has been the motion picture, which has assumed a real professional status. In many cases well-known Hollywood talent has been employed to act the parts, and the sequences have been made interesting enough so as to conceal the bare-faced selling of former types of film. With these shows, of course, have come the pep talks from sales managers and presidents. It would be hard to find a more bullish group than we have in this territory at the present time. There is not an automobile executive who has not thoroughly sold himself on the fact that his product is better than ever before and that his company is going out for the lion's share of the business in 1937.

Sloan Predicts Good 1937

Alfred Sloan, in several speeches, has indicated that 1937 will be a very good year for General Motors and estimates that a 30 per cent increase in sales would not be painting the picture too optimistically. Beyond '37 he does not care to predict, owing to the many economic factors, particularly Government spending and its attendant taxation, which may tend to slow down the present tremendous upsurge in automotive business. He looks to the coming housing boom, plus the obsolescence factor in the heavy industries, to be vitalizing influences which will maintain our present upward swing. That these sentiments are more than a pious hope on the part of automotive manufacturers is evident from the big spending programs that have taken place during the past year.

Chevrolet has staked $26,000,000 in new machinery, rearrangement of plants and assembly lines and re-tooling for the 1937 models that will be announced early in November. This is one of the largest sums ever appropriated by the automotive industry for a model change-over and would not have been made unless the company saw a chance of getting back a part of this expenditure, at least, in increased sales this year. Chevrolet has completely re-designed its car from bumper to bumper, with an entirely new body, chassis, engine, transmission and hypoid rear axle. The motor, although still retaining the valve-in-head feature, has had its stroke and bore equalized, mak-

ing what is known as a "square" engine so as to give smoother operation at higher r.p.m.'s. Chevrolet is now in production on the new models and schedules at the factories are increasing daily, with a heavy volume slated for the latter part of October. November and December will probably see Chevrolet production increased over the high mark set last year for those two months. Production of 1,200,000 units in 1937 is planned, according to W. E. Holler, general sales manager.

Pontiac, after fabricating almost 50,000 more units in 1936 than in 1935, is laying broad plans for a minimum increase in sales in every territory of at least 30 per cent. The capital outlay for 1937 production is $6,000,000, which went mainly into the new axle plant described last week. Buick is increasing its daily volume from 800 to 1000 cars, and Oldsmobile's new assembly line will have a capacity of 80 cars an hour in place of 55.

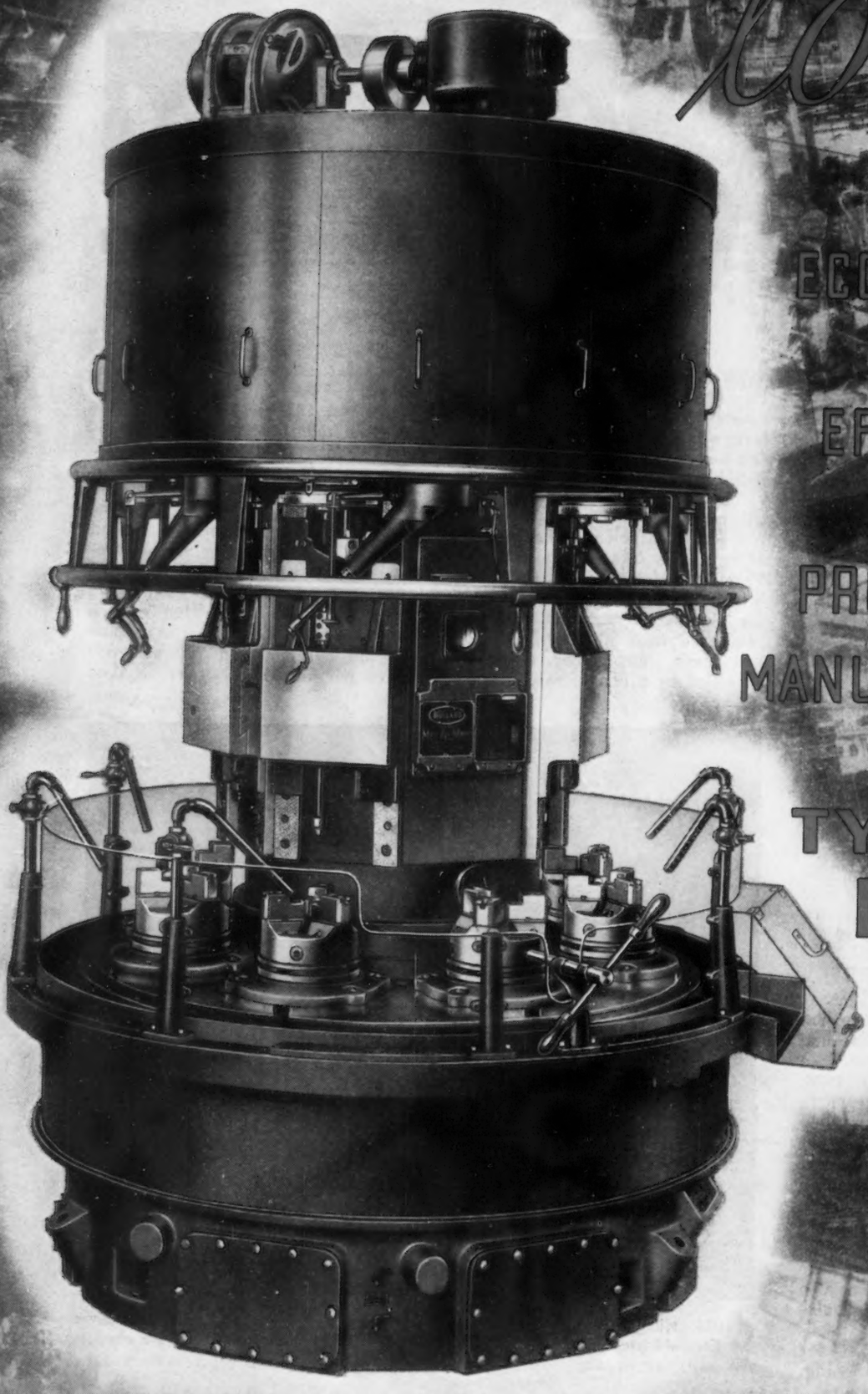
Chrysler Executives Optimistic

Chrysler executives are just as optimistic as those of General Motors. Plymouth predicts the sale of 600,000 cars in 1937, almost a 20 per cent increase over 1936. Dodge plans a similar increase in schedules. DeSoto has an entirely new assembly line, stamping plant and motor line, which should put this division of the corporation in a very good competitive position. Assemblies of the new DeSoto are already under way and about 20 cars an hour are rolling off the line. Chrysler sales division also looks to some sensational new sales records in 1937. There is a definite feeling that the market for higher priced cars is broadening.

This feeling is borne out by Packard's sales figures, which indicate that the demand for the larger and more costly Packards is far heavier than had been anticipated earlier in view of the obvious competition of the 120 and the new Six. In fact, all records for sales, shipments and delivery of new cars in the history of the Packard Motor Car Co. were broken in September. Total sales for September were 12,851 units compared with 3603 in September last year. September shipments exceeded by a considerable margin the total shipments made during each of the entire years 1932, 1933 and 1934. At the beginning of this month there was a bank of 13,335 unfilled orders on hand. As a result, production has been stepped up for 1500 additional 120 cars and 200 of the more expensive models each month. A second assembly line is now being prepared for the 120 and Packard Six cars, where special body types will be built. Production of the Packard Twelves and Super-Eights should run between 750 and 880 cars per month in order to keep

CHIEF styling changes are in the front ends this year. Horizontal grille and louvre lines will predominate. A. E. Barit, president of Hudson, points out the changes in the 1937 Hudson.

Industries Answer to



MORE ECONOMICAL

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EFFICIENT AND PROFITABLE MANUFACTURING

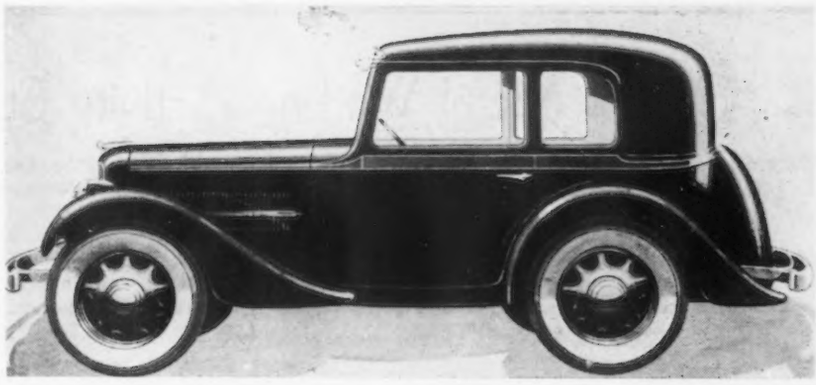
•

TYPE D MULT-AU-MATIC

THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT

pace with present demand. As is apparent from the above figures, the introduction of the Six has not affected sales of the 120 adversely, but has rather increased them. Studebaker also reports a tremendous increase in sales for September—11,110 units, as against 2197 in September a year ago. In fact, last month's sales were larger than any month since March, 1929, covering a period of 90 months. Export shipments broke all monthly records since November, 1928.



AMERICAN Bantam business coupe, $335 f.o.b. Butler, Pa. Dealers' orders for 19,107 of eight new models have been received up to Sept. 30. Economy of operation is stressed for a light delivery unit.

Motor Production on Upswing

With assembly lines getting into full swing, it is not surprising to find that automotive production almost doubled that of the previous week. Ward's Automotive Reports estimates production of passenger cars and trucks in the United States and Canada at 41,360 units for the week ended Oct. 10, compared with 23,175 in the previous week and 52,950 in the corresponding week last year. The fact that the current figure is still below that of 1935 can be accounted for largely by the fact that Ford Motor Co. was not in production. Chevrolet's output is still extremely low, but Pontiac's assembly of approximately 600 units a day has brought up the total of General Motors' output to 13,750 units, compared with 3500 the week before. Chrysler units assembled a couple of thousand more units than General Motors.

Ford is still the doubtful factor in the picture, although it is expected that assemblies will start in a small way this week. Banks of motors and other component units are being built up, so that when lines do get running, Ford will get into production fast. The principal factor in Ford's delay has been a last-minute decision on brakes, necessitating new forging dies to be constructed at the last moment. A clue as to what the new Ford will look like is given in photographs coming from Europe of the new Ford 22-hp. car. The front end resembles the Lincoln-Zephyr in appearance very closely, although the rear body panel does not have quite the angular tilt of its big brother. The English job also has pressed steel spoked wheels comparable with the present Zephyr.

When the Ford assembly lines get rolling, they will roll fast. It is understood that approximately 225,000 cars and trucks have been budgeted for assembly up to Dec. 10. Of this number, approximately 25 per cent will be powered by the small V-8 engine, which has been in production now for three or four months. In fact, the last report had it that approximately 650 to 700 of these small engines were being built each day. Like the bigger V-8 engine, the cylinder blocks and crankcase are cast as a unit, but because of the difficulty in coring such a small casting for the water space, the sides of the cylinder banks have been left open as cast. The water compartment is enclosed by spot welding stainless steel sheets on the side. This particular process is a closely guarded secret of the Ford Motor Co. and represents the results of two years of research in finding a practical means for welding stainless steel to cast iron. It is understood that the chief element is the exceedingly small time involved in making the weld—a fraction of an a.c. cycle—in order to avoid pitting under the weld and to assure a proper bond.

MOST striking feature of the interior of the new Lincoln-Zephyr, 1937 model, is the instrument panel design, which finds no counterpart in any other 1937 model. Its uniqueness lies in the enclosed grille extending down to the top of the transmission housing and behind which the heater and radio loud-speaker are concealed. Centralization of the speedometer dial and clock is an innovation, as is the use of two glove compartments. Body changes are minor.

Lincoln-Zephyr Shown

Lincoln-Zephyr announced its new 1937 cars on its first anniversary. Few changes have been made in body contours, but this still leaves the Zephyr the most completely streamlined car built in production volume. Some bright chromium plated metal has been added to the radiator grille and hood louvers to add to the appearance of gliding motion. The most striking feature of the car interior is the instrument panel design, which includes a new enclosed grille reaching down to the top of the transmission housing and designed to screen the car heater and radio loud speaker. The radio unit itself is concealed under the front seat.

There has also been a new arrangement of the luggage space in the rear, reached through the rear deck hatchway. When the deck is lifted, the spare tire can be swung out of the way on its pivoted rack, thus giving access to the luggage space. A new steering system has also been included. Transverse cantilever spring mounting is employed as before, with a spring base of 133 in. on a wheelbase of

(CONTINUED ON PAGE 245)

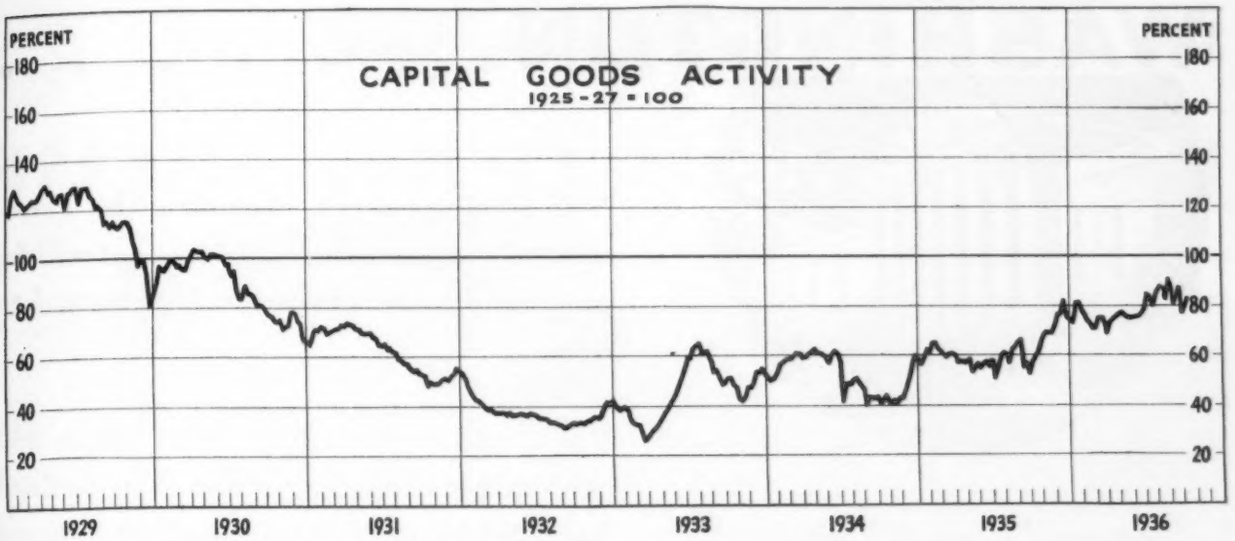
Current Metal Working Activity Statistically Shown

These Data Are Assembled by The Iron Age from Recognized Sources and Are Changed Regularly as More Recent Figures Are Made Available.

	August, 1936	July, 1936	August, 1935	Eight Months, 1935	Eight Months, 1936
Raw Materials:					
Lake ore consumption (gross tons)[a]	3,968,845	3,826,050	2,615,927	19,170,108	27,407,391
Coke production (net tons)[b]	3,993,602	3,828,548	2,833,707	22,468,866	29,117,450
Pig Iron:					
Pig iron output—monthly (gross tons)[c]	2,711,721	2,594,268	1,761,286	13,080,549	18,834,215
Pig iron output—daily (gross tons)[c]	87,475	83,686	56,816	53,829	75,944
Castings:					
Malleable castings—production (net tons)[d]	42,253	44,413	35,245	296,057	360,758
Malleable castings—orders (net tons)[d]	45,179	41,031	35,602	281,356	351,265
Steel castings—production (net tons)[d]	81,574	78,654	34,972	247,022	501,810
Steel castings—orders (net tons)[d]	59,393	74,001	45,426	262,366	556,948
Steel Ingots:					
Steel ingot production—monthly (gross tons)[e]	4,195,130	3,922,731	2,915,930	21,226,408	29,444,196
Steel ingot production—daily (gross tons)[e]	161,351	150,874	107,997	102,543	141,559
Steel ingot production—per cent of capacity[e]	73.52	68.74	48.78	46.31	64.5
Finished Steel:					
Trackwork shipments (net tons)[e]	6,401	6,216*	4,028	29,657	47,209
Steel rail orders (gross tons)[e]	5,800	56,880	9,400	317,157	659,028
Sheet steel sales (net tons)[f]	207,781	192,873	207,140	1,558,438	1,608,740
Sheet steel production (net tons)[f]	202,456	217,651	206,613	1,578,011	1,694,765
Fabricated shape orders (net tons)[g]	95,390	188,053	102,859	687,806	1,034,114
Fabricated shape shipments (net tons)[g]	127,106	147,824	122,749	728,145	952,344
Fabricated plate orders (net tons)[d]	28,319	60,324	23,628	141,980	318,125
Reinforcing bar awards (net tons)[e]	33,770	45,245	13,590	136,140	255,610
U. S. Steel Corp. shipments (tons)[h]	923,707	950,851	624,497	4,726,290	6,905,904
Ohio River steel shipments (net tons)[i]	113,560	110,495	92,501	578,613	689,676
Fabricated Products:					
Automobile production, U. S. and Canada[k]	275,951	451,474	247,686	2,970,913	3,322,249
Construction contracts, 37 Eastern States[l]	.....	$294,833,800	$168,557,200	$1,024,423,000	.....
Steel barrel shipments (number)[d]	588,660	752,223	600,993	4,189,606	5,186,644
Steel furniture shipments (dollars)[d]	.....	1,510,716	1,327,252	9,450,546	.....
Steel boiler orders (sq. ft.)[d]	1,074,597	1,109,849	543,975	3,736,620	6,846,063
Locomotive orders (number)[m]	3	9	0	21	134
Freight car orders (number)[m]	3,225	4,469	100	7,183	34,248
Machine tool index[n]	127.5	150.1	125.8	†112.2	†135.5
Foundry equipment index[o]	145.4	159.6	113.0	†102.4	†148.8
Foreign Trade:					
Total iron and steel imports (gross tons)[p]	60,697	47,940	32,312	247,069	427,782
Imports of pig iron (gross tons)[p]	12,524	12,496	8,568	67,573	122,527
Imports of all rolled steel (gross tons)[p]	28,216	19,638	17,657	129,348	171,622
Total iron and steel exports (gross tons)[p]	295,341	296,738	247,312	2,136,781	2,223,670
Exports of all rolled steel (gross tons)[p]	89,128	93,365	82,866	577,704	715,983
Exports of finished steel (gross tons)[p]	79,617	83,599	64,400	497,988	650,530
Exports of scrap (gross tons)[p]	194,600	192,817	156,658	1,481,126	1,437,690
British Production:					
British pig iron production (gross tons)[r]	635,800	661,100	543,400	4,263,700	5,046,000
British steel ingot production (gross tons)[r]	872,700	974,100	759,900	6,364,400	7,591,000
Non-Ferrous Metals:					
Lead production (net tons)[s]	33,542	39,576	34,856	261,759	297,133
Lead shipments (net tons)[s]	46,388	38,996	38,195	268,202	299,861
Zinc production (net tons)[t]	43,614	45,553	35,547	280,543	352,899
Zinc shipments (net tons)[t]	46,085	41,891	38,824	286,102	340,463
Deliveries of tin (gross tons)[v]	5,385	7,120	5,320	39,000	49,525

†Three months' average. *Revised.

Source of figures: [a] Lake Superior Iron Ore Association; [b] Bureau of Mines; [c] THE IRON AGE; [d] Bureau of the Census; [e] American Iron and Steel Institute; [f] National Association of Flat-Rolled Steel Manufacturers; [g] American Institute of Steel Construction; [h] United States Steel Corp.; [i] United States Engineer, Pittsburgh; [k] When preliminary, from Automobile Manufacturers Association—Final figures from Bureau of the Census; [l] F. W. Dodge Corp.; [m] *Railway Age;* [n] National Machine Tool Builders Association; [o] Foundry Equipment Manufacturers Association; [p] Department of Commerce; [r] British Iron and Steel Federation; [s] American Bureau of Metal Statistics; [t] American Zinc Institute, Inc.; [v] New York Commodities Exchange.



Weekly Index of Rate Activity in Capital Goods, Adjusted for Seasonal Variation, 1925-27 Average = 100

THE IRON AGE Weekly Index Numbers of Capital Goods Activity

(1925-27 Average = 100)

Last week	82.9*	Same week 1933	51.3
Preceding week	77.7	Same week 1932	33.5
Same week last month	84.3	Same week 1931	52.0
Same week 1935	59.0	Same week 1930	76.2
Same week 1934	42.5	Same week 1929	112.1

ACTIVITY in the durable goods industries continued to rise last week, according to incomplete reports from the five major industries which THE IRON AGE barometer of business measures. The rise was more pronounced than that which occurred for the preceding week, and the business curve moved definitely out of the slight slump felt in the last half of September. The index of activity rose from 77.7 per cent of average in the first week of October to a tentative 82.9 per cent in the week ended Oct. 10.

This contrasts with an average rate during September of 82.0 per cent and for August of 86.5 per cent, the high for the recovery period to date, the peak week in August having been 90.8 per cent. It compares with a figure approximately 24 points lower in the same period last year.

Among separate industries, there was marked improvement in automotive output last week, aggregate assemblies having about doubled the previous week's volume. Industrial production at Pittsburgh gained, largely due to greater activity in steel, but, while the steel ingot rate for the nation as a whole also rose, the gain was less than seasonal, and a slight drop was therefore recorded in the adjusted component steel index. This was the first recession in this series in a month.

*Preliminary.

Components of The Index (1) Steel Ingot Production Rate, from THE IRON AGE; (2) Automobile Production, from Ward's Reports, Inc.; (3) Revenue Freight Carloadings of Forest Products, from Association of American Railroads; (4) Industrial Productive Activity in Pittsburgh District from Bureau of Business Research of University of Pittsburgh; (5) Heavy Construction Contract Awards, from *Engineering News-Record*.

Steel Men to Meet with Bankers

IN a search for a more scientific basis for bank credit to the steel construction industry, the American Institute of Steel Construction has planned this year a novel experiment in connection with its annual convention to be held at White Sulphur Springs, W. Va., Oct. 21 to 23. Following the conclusion of the regular sessions the members will be invited to participate on Saturday, Oct. 24, in a joint conference with the credit officers of banks who will be meeting at Hot Springs, Va., at the same time.

The credit group, which is known as the Robert Morris Association, is primarily interested in the close study of financing problems and credit extension as related to different types of industry. This is the first time, however, that it has endeavored in a joint open conference with a single industry.

J. Lloyd Kimbrough, president, Indiana Bridge Co., Muncie, Ind., will speak on "Financing Problems in Structural Steel," and C. Oliver Wellington, Scoville, Wellington & Co., New York, will address the session on "Costs, Prices and Profits."

WASHINGTON . . . . . .

. . . *New Deal speakers, including the President, do not indicate policies that will be pursued if administration is returned to office.*

o o o

. . . *But group surrounding Roosevelt is still demanding radical moves such as revived NRA, 30-hr. week and renewal of Federal control.*

o o o

. . . *Details of new freight rates proposed by railroads to go into effect Jan. 1—Myron C. Taylor confers with President.*

o o o

By L. W. MOFFETT
Resident Washington Editor, The Iron Age

o o o

WASHINGTON, Oct. 13.—In his recent political speeches President Roosevelt has told, as have his multitude of subordinates, how the New Deal has brought about recovery and a vast array of other blessings. To accept the oleaginous drool of some New Deal zealots would be to believe the sun's rise awaited the crowing of the New Deal rooster. Unbiased sources, as for instance, the Secretary General of the League of Nations, who in a report on the world economic situation to the Assembly at Geneva, shows that the depression reached its lowest point in the summer of 1932 and that "Since then there has been a persistent, indeed an accelerating, if uneven recovery." The United States lagged and still lags as compared with other nations, though making rapid progress the past year, but still seeing a depressingly long list of unemployed, taxes shot up again and again, expenditures continuing to be about twice the income, with much talk but no action in the direction of economy.

The recovery in the United States undoubtedly has been partially due to the unshackling of industry and agriculture . . . of enforced abandonment, thanks to the Supreme Court, of regimentation in the way of the NRA and AAA. . . . in other words, there has been recovery *despite*, not on account of the New Deal.

What Will New Deal Do if Continued in Power?

Which brings to a point the pertinent fact that in the course of all its campaign discussions the New Deal has not said what it proposes to do with regard to some important problems if it is continued in power . . . because some fundamental changes in the constitutional form of the United States have been attempted and many think will be pursued, the election, three weeks from today, is commonly viewed as the most important election since the Civil War . . . the vague Philadelphia platform is not an answer as to what plans the New Deal has in mind . . . the Republican party plans themselves are far from being crystal clear in some respects . . . but on one important point it is definite . . . it has pledged itself against regimentation, though, like the New Deal, it has promised the farmer most anything he wants . . . and remembering what happened to the Democratic platform of 1932, why take the Philadelphia platform seriously? . . .

There are those who say that if reelected President Roosevelt will be more conservative than he has been. . . . Likewise there are those who say he will swing more abruptly to the left . . . and wisest of all there are those who admit they don't have the least idea what he may do. . . .

But it is certain that around him Mr. Roosevelt has a group who strongly favor radical moves and renewal of regimentation . . . and they are not confined to the Brain Trust. . . . Cutting the subject to one issue, what are the plans with respect to reviving NRA or a substitute? . . . Secretary of Commerce Roper, who never warmed to the defunct Blue Eagle, has said it is not proposed to revive it. . . . But organized labor and other groups have insisted on its revival or revival of a substitute and clearly would handle the Supreme Court roughly to that end, if they could get away with it. . . . Keenly urging another NRA or its alter ego, is Major George L. Berry, who is "Coordinator of Industry," head of the New Deal Labor's Non-Partisan League and president of the Printing Pressmen's Union, a union which seems to enjoy the "democracy" of never having an annual meeting. . . . Major Berry

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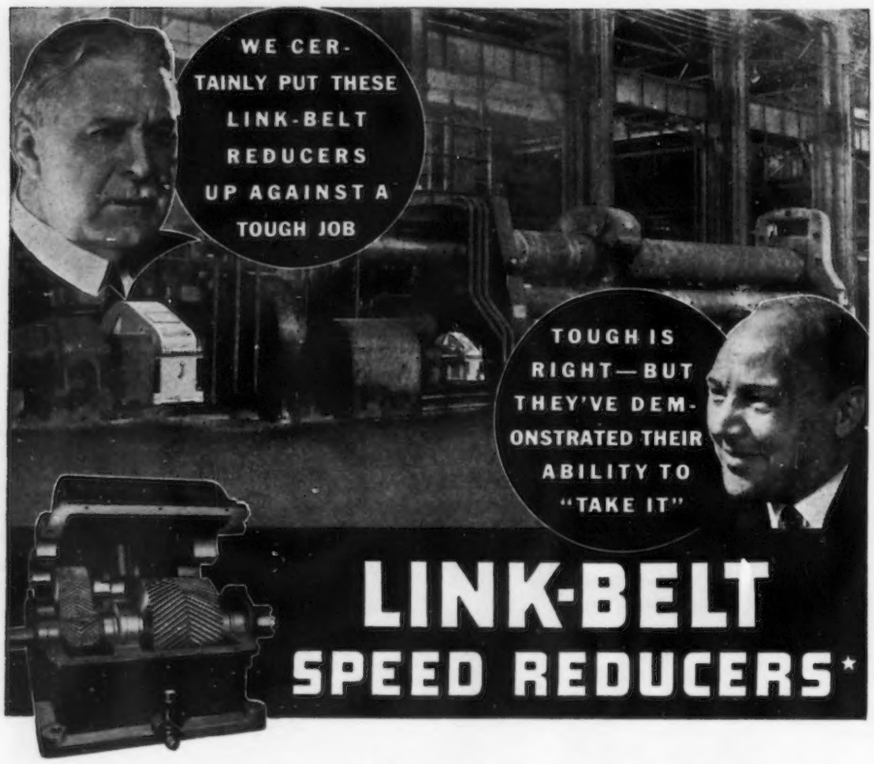
has called a meeting, however, of the "Council for Industrial Progress" for Dec. 6 to see what can be done about the Supreme Court situation. . . . With other organized labor leaders he is desperately campaigning for the reelection of President Roosevelt . . . the Major has said that union labor organizations expect to spend in excess of $1,000,000 to reelect Mr. Roosevelt . . . speaking this time as head of the "Non-Partisan" League, the major said $350,000 will be spent by the League's national headquarters in Washington and the remainder will be spent in the States by local branches of the League . . . which has such doughty campaigners as Senator Couzens, Michigan, Republican; Senator Norris, Nebraska, Republican; Mayor Fiorello H. LaGuardia of New York, Republican, and Senator La-Follette, Wisconsin, Progressive, who, leaving their parties, are praised, while Al Smith, leaving the New Deal, is damned . . . and one can imagine what would be said of industrialists if they announced their purpose of spending $1,000,000 in a drive to elect Mr. Roosevelt's opponent . . . though of course labor, industry or any other group has a right to raise campaign money so long as it is raised and spent legitimately. . . . Berry said he has personally pledged the generous sum of $25,000, but the largest single contribution has come from the ample Treasury chest of John L. Lewis's United Mine Workers of America . . . other labor groups making up the Non-Partisan League, which in turn is made up of largely Lewis's Committee for Industrial Organization, have contributed to the kitty and are on the political hustings for the New Deal. . . . All this to deliver a strong labor vote to the President . . . and to form a Labor Party which it is proposed to throw into the national campaign in 1940, Lewis for President and Berry for Vice-President, so it is widely reported. . . .

Groups Surrounding Roosevelt Still Seeking Radical Moves

Certainly if these groups deliver the vote they seek and thereby are wholly or substantially responsible for reelection, they are going to expect lucrative dividends at the hands of the New Deal in return. . . . How could the New Deal possibly refuse them? . . . for whether or not there is a break later with the groups it certainly would be expected that they and the New Deal would go along together for some time . . . and since these groups are demanding another NRA and other forms of regimentation, including the 30-hr. week — ready, it is suspected, to "compromise" on the latter — how could the President refuse to support them and demand such legislation? . . . Just how valid legislation of the kind could be enacted in view of the Supreme Court decision in the Schechter case is a puzzle but that probably would be a minor obstacle . . . means of circumventing court decisions have become common . . . though such means themselves are being challenged in the courts. . . .

And if the demands for industrial regimentation coming from Berry, et al. are not sufficient indication that they will be projected in the event of the reelection of President Roosevelt, there is the declaration of Madam Secretary of Labor Frances Perkins which must be taken into account. . . . This member of the New Deal cabinet,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according to *The New York Times*, told the Good Neighbor League in New York last week that the basic principles of the NRA were "just and sound" and that a way would be found to execute them. . . . "If the way in which it (NRA) was attempted in the first place was not the right way, then the ingenuity of the people of the United States will find another way," said Miss Perkins. . . . So long as they are reasonable and given necessary flexibility, approval is readily given to the statement of Miss Perkins that shorter hours of labor mean wider distribution of jobs . . . and the desirability of eliminating child labor is obvious of course . . . so is the desirability . . . the necessity . . . of decent wages . . . but the difficulty is once business gets into the strait-jacket, as it did under NRA, it faces growing pressure for still shorter hours and still higher wages before they can be granted . . . and in the end this means increased unemployment and prolonged depression . . . prices that consumers can't pay . . . and elimination of competition which would destroy the very fundamentals of a democratic form of government. . . . Miss Perkins clearly was more restrained than are the active proponents for another NRA . . . she was vague, but did not refer to possible legislation, though it is the belief she has legislation in mind . . . that fact hardly seems to be obscured by euphonious reference to the "ingenuity of the people" finding another way. . . . Does the Walsh-Healey Act point the way? . . . Her statement does not seem to square with that of her colleague in the cabinet, Mr. Roper . . . but conflicting statements from New Deal sources are quite common and it is idle to attempt to reconcile them . . . and in this instance there is strong evidence pointing to the fact that the New Deal distinctly has further regimentation in mind if it is continued in power . . . a sign pointing in that direction is the intimation the President already has given that he will ask for extension of his "emergency" power to devalue the dollar down to 50 per cent of its former gold value . . . that is to say, he proposes to again ask for that power and not to restore the power to Congress, where it belongs.

So in discussing a widespread range of subjects, Mr. Roosevelt would render a service to the country if he would say specifically whether he proposes, or does not propose, a program of regimentation . . . and if he has such a program in mind in any form he would do well to explain it in clear detail.

Details of Proposed New Freight Rates

WASHINGTON, Oct. 13.—Briefly outlined in THE IRON AGE of Oct. 8, proposed increased rail rates on iron and steel products and their raw materials are part of schedules which have been prepared to replace existing surcharge rates. The latter expire Dec. 31 by order of the Interstate Commerce Commission.

It is proposed to increase iron and steel commodity rates 10 per

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cent with a maximum of 1c. per 100-lb., or 20c. per net or gross ton, as rated. The schedule calls for an increase of 1c. per 100-lb. in column rates on iron and steel products. Pig iron is included in these products.

Iron and steel move mostly on commodity rates. There are some instances where special scales have been fixed by the Interstate Commerce Commission. Likewise there are instances where the railroads have voluntarily made departures.

On scrap iron and steel it is proposed to increase commodity rates 20 per cent with a maximum of 20c. per ton within Western territory and from and to Western territory. In other territories commodities rates on scrap would be increased 10 per cent with a maximum of 1c. per 100-lb., or 20c. per ton. Within, from and to Western territory, where column ratings of 15 per cent and 12½ per cent at minimum weights of 50,000 and 75,000 lb., respectively, are applicable to scrap it is proposed to cancel the 12½ per cent column rating at the 75,000 lb. minimum.

On Lake iron ore the rate from mine to port would be increased 5c. per net ton or 6c. per gross ton. Where there is rail transportation beyond Lake ports these rates also would be increased 5c. per net ton or 6c. per gross ton as well as the inclusion of the same amount in local rates. The 40c. iron ore rate in Alabama would become 50c.

On coal the rates would be increased 3c. up where the rates range up to 75c. per net or gross ton; 5c. per net and 6c. per gross ton where they range from 76c. to $1; 10c. per net and 11c. per gross ton where they are over $1. In Western territory rates would be increased 1c. per ton where they are $2 or over. There is one exception. On Lake cargo coal the proposed increase from Lake Superior and Lake Michigan docks is 5c. to the send that the increased charges by rail-lake-rail will be the same as the increase when the coal is moving all-rail. Like increases are proposed on coke.

On fluxing stone and dolomite, not roasted, it is proposed to increase conformity rates 5c. per ton where rates are over 60c. per ton to and including $1; 10c. per ton in rates over $1 per ton. Rates to or within Chicago would not be changed. On roasted dolomite it is proposed to increase commodity rates 1c. per 100 lb. or 20c. per ton, net or gross. Column rates of 60 per cent of sixth class in Central Freight territory would be increased to Column 17½; column rates of 12 per cent where now applicable in certain other territories would be increased to Column 13. On crushed limestone commodity rates over 60c. per ton to and including $1 per ton would be increased 5c. per ton. Commodity rates over $1 per ton would be increased 10c. per ton. Where in Official territory Column 60 per cent of sixth class is now applicable it is proposed to change to Column 16½ of first class, an increase of 10 per cent.

On non-ferrous metals it is proposed to increase column rates two percentage points and commodity rates 10 per cent with a maximum of 2c. per 100 lb., except that intra-territorially in Official territory no increase is to be made.

On machinery and boilers, including electrical machinery, appliances and supplies, class or column rates lower than Column 40 would be increased to Column 40. This would involve an increase in Official territory from fifth class (35 per cent) to Column 40. Commodity rates in all territories on electrical machinery appliances and supplies would be increased 10 per cent and on the other machinery and boilers rates would be increased 10 per cent with a maximum of 5c. per 100 lb. On agricultural machinery and parts, other than hand, class or column rates lower than Column 40 would be increased to Column 40. This would involve increasing rating in Official territory from fifth class (35 per cent) to Column 40 and in Southern territory between Southern and Official territories from Column 37 to Column 40. Commodity rates in all territories would be increased 10 per cent with a maximum of 5c. per 100 lb.

It is estimated by the carriers that these increases if permitted to go into effect would raise $50,000,000 annually in revenue. The present surcharges raise an estimated annual revenue of $100,000,000.

J. J. Pelley, president of the Association of American railroads, said that as part of the general adjustment, the railroads contemplate an important step toward simplicity in rates and tariffs by making practically uniform for the entire country the classification of all articles now moving on first, second and third class rates in less than carload lots in each of the three major traffic territories, Official, Western and Southern. This result would be accomplished in practically all instances by making the ratings in all territories the same as the lowest classifications now in effect in any territory. This is looked upon as the most important single step ever taken toward simplifications and uniformity in the freight rate structure of the country.

No general increases in the class rates will be proposed except that in the Official territory and between Official territory and Western territory where the rates are governed by Official classifications the following changes are to be suggested:

Fifth class to be revised from 35 per cent to 37½ per cent of first class.

Sixth class to be revised from 27½ per cent to 30 per cent of first class.

The proposals, officials stated, involve about 1700 reductions in and some 50 to 60 increases in present rates.

Myron C. Taylor Visits White House

WASHINGTON, Oct. 13.—Myron C. Taylor, chairman of the United States Steel Corp., was an invited White House caller last Wednesday when he was in conference with President Roosevelt. Approached by four news correspondents upon leaving the President, Mr. Taylor declined to say what was discussed, explaining that if any statement were made it should come from the President. The President did not disclose the nature of the conference.

British Steel Works Introduces Pensions

LONDON (*Special Correspondence.*—The biggest industrial life insurance and pension plan of its kind in the United Kingdom has just been initiated by the United Steel Companies, Ltd., the largest steel producing organization in Britain and makers of about one-sixth of the steel of the country. The plan covers the whole of the combine's 21,000 employees engaged with 17 separate companies at Sheffield, Ickles, Scunthorpe, Workington, Stocksbridge, Wellingborough, and Barrow-in-Furness. The average wage of the employees is slightly more than $15 a week.

Never before has a British industrial firm of this size or kind provided pensions for its rank and file manual workers.

The plan provides a pension for

members of the staff at 65 at the rate of 12c per week for each year of service from the date of the start of the fund, and the company has agreed to pay the difference between the cost of the benefit and the amount employee will pay. The company is making a further contribution so that employees over 45 who join at the outset and contribute continuously until 65 will have a minimum pension of $2.50 per week.

Provision is made for a member, on giving notice to the insurance office, to accept a reduced pension which, after his death, will continue to be paid to his widow for the remainder of her life. The company may permit a man to retire on a reduced pension payable immediately on retirement at any time after 55 years of age. It has also agreed to bear the whole cost of a death benefit of $515 payable to a dependent or dependents.

For the purpose of contributions the employees are divided into two wage classes, one to pay 12c. less per week than the other for exactly the same benefits. The directors point out that the company will thereby pay more toward the cost of the pensions of the lower paid members than for the higher paid. Thus, if an employee's wage does not exceed $12.50 per week he will contribute 25c. per week to the fund, and if the wage is above this level he will pay 50 per cent more.

The results, the combine hopes, will be far-reaching. It is argued that a man of 65 who gets $5 a week pension will have, with the addition of his old age pension, $7.50 a week, and with his wife's old age pension as well, $10 per week to live on. As such a man has raised a family on $15 weekly all his life, this will be a modest sufficiency now that his family is self-supporting.

The 126,000 steel workers in Sheffield and the rest of the country will watch the outcome of this plan with intense interest, as will large employers of labor as well. Steel workers constitute one of the largest groups of laborers in Britain.

There are at present 800,000 men over 65 in British industry who cannot retire because they have saved nothing. The introduction of pension plans by their employers would enable them to retire instantly and have their places taken by 800,000 younger men now unemployed. The success of the United Steel combine's experiment would go far toward bringing this about.

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Write for booklets covering lubrication problems in your plant. List subjects or types of machinery in which you are most interested.

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CORRECT LUBRICATION

British Rush Steel Plant Construction

LONDON, ENGLAND (*Special Correspondence*).—Work on new steel plants is being pushed forward in the United Kingdom in an effort to make good the shortage which has developed in many steel products.

The new South Durham Steel & Iron Co.'s works at Stockton-on-Tees is near completion. Work on the renovation of the Ebb Vale plant for Richard Thomas is advancing rapidly. As soon as these plants are in operation there should be a further substantial decrease in unemployment in the British steel industry.

At present the number of registered unemployed in the pig iron section is 13.9 per cent of the total workers registered in this section, while in the steel melting, puddling and rolling section the percentage is as much as 16.2 per cent. The large percentage still unemployed in the pig iron section is surprising, as consumers are unable to obtain anything like the full amount of pig iron they require without substantial delay.

Many blast furnaces still remain inactive, but they are mostly in areas such as Jarrow, where the resumption of operations is considered uneconomic. Until new blast furnaces are built in areas where full production of steel is in progress, the shortage is likely to continue.

There is still considerable unemployment among puddlers. The tremendous demand, which has sent British production rocketing to new high levels, is coming chiefly from the shipbuilding and armament industries, and barely affects the wrought iron section. Meanwhile, since domestic demand is absorbing the greater part of the steel produced in Britain, the export trade is having to fend for itself and is having a difficult time.

Many exporters complain that they are unable to fulfil orders that should have been completed some time ago and fear that they may lose future business. The danger of such losses, however, is discredited, as steel industries abroad are becoming increasingly occupied with domestic demand and it is contended that there is no other source to which customers can turn.

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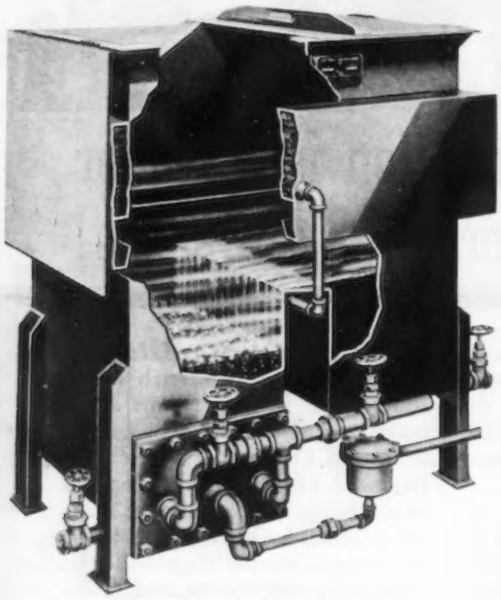

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Stainless Steel Orders Hit New High

ACCORDING to W. J. McArdle, general sales manager, Allegheny Steel Co., Brackenridge, Pa., the company's bookings of stainless steel orders in the eight months ended Sept. 30 were the largest for any corresponding period in the company's history, and September bookings constituted the largest single month in its record. During 1936 household demands have superseded the chemical industry as the second largest consumer of this company's stainless steel, the automotive industry remaining as the largest tonnage consumer.

Submitting a figure of $6,374,073.66, the Consolidated Aircraft Corp., San Diego, Cal., was low bidder for the construction of 66 patrol airplanes of the flying boat type for the Navy Department. The Glenn S. Martin Co., Baltimore, bid was $7,106,120, while the Douglas Aircraft Co., Santa Monica, Cal., bid was $8,540,077.

Metal Trades Inaugurate Plan For Industrial Cooperation

DESIGNED to bring about better relationship between management and men; to cause study of all sides of industrial relations; and to promote cooperation, the National Metal Trades Association has in preparation a program for "Industrial Cooperation Under Progressive Management." It is being assembled by a committee consisting of Henry W. Johnson, De Laval Steam Turbine Co.; Harvard Dunbar, Norton Co.; J. S. Knowlson, Stewart-Warner Corp.; Louis Ruthenburg, Servel, Inc.; and J. F. Kolb, National Metal Trades Association.

This committee has set forth the following fundamental principles:

"The metal trades industry has no cause to apologize for its attitude or its accomplishments. It has no reason to stand silent under adverse criticism.

"In the progress of the industry both management and employee have prospered, not by accident but because the industry has long recognized that its growth was always from the roots; that the top was constantly being replenished from the bottom; that unless the employee prospered, grew, and matured, business died at the top. The apprentice of today is the manager of tomorrow.

"So vital is the mutuality of interest between management and employee that one cannot prosper without the other, that any agency or effort that tends to harm or destroy the one automatically harms and may destroy the other.

Is Your Plant Known as a Good Place to Work?

"The manner in which an industrialist handles problems of common interest becomes a matter of interest to all. His success or failure to develop a plan of cooperation with his workers will be felt by every industry in his community and by every unit in the industry. Therefore, with this common interest at hand, the time is ripe to make a personal audit of the situation in each plant and the committee suggests a self-examination of 26 questions, among them being the following:

1. Is your plant known locally as a "good place in which to work"?
2. Is your factory a pleasant place to work with particular reference to safety, sanitation, cleanliness, light, etc.? Is it satisfactory to you?
3. Have you any plan for getting together with your employees to work out common problems in a spirit of friendly cooperation?
4. Do you make a point of personally meeting your employees and discussing their problems with them?
5. Do you have written factory rules and regulations covering your labor policy?
6. How does your plant labor turnover compare with the turnover in other plants in your community?
7. Do you have any shop activities such as foremen's clubs, ath-

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No longer do you need three hands to do a centering job. You depress the lever that withdraws the spring center—*with the same hand that holds the work.*

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THE TAFT-PEIRCE MFG. CO.

WOONSOCKET RHODE ISLAND

letics, superintendents' clubs, picnics, etc., that have been initiated and organized by your employees?

Competent Leadership Will Be Accepted by Men

"It is difficult to imagine a more serious misconception than the assumption that American workmen will understand the industrial system with all its involved social and economic implications. The fact that competent leadership will be accepted by human groups is unchanged. Therefore the progressive manager knows that he must sell to his organization the fairness, justice, profit-to-all and advantages-to-all of company policies. The manager must use persuasion rather than make demands; explain rather than give orders; lead instead of drive. Employees will not turn to outsiders for guidance unless the employer fails as a leader.

"The progressive manager knows that in order to establish fully effective cooperation he must give careful attention not only to proper cooperative functioning of line and staff organizations but he must establish and maintain certain direct contacts between himself and the working force."

Having reviewed the above situation, the committee again sets forth a group of personal questions designed to help a manager obtain a picture of the exact status of his program. Some of these questions are:

1. What are the net results of your methods of handling men?
2. Are you sure the line contacts in your plant transmit to you the information you should receive about your workmen and their problems?
3. Is your staff dealing promptly and correctly with the problems resulting from misunderstandings between workmen and their supervisors?
4. Does your labor policy provide a method by which an employee may present a grievance or air a grouch without danger of having his job put in jeopardy?
5. Do you take your supervisory staff into your confidence and discuss with them the advantages of all of company policies, the actual condition of the business, and the probable effect of business trends on the employees?
6. Do you prepare over your own signature personal messages to your workers, to be published in your factory papers or to be placed on factory bulletin boards?

Proper Training as a Basis for Cooperation

The next subject considered is that of training as a basis for cooperation. Inadequately trained intermediaries — superintendents, foremen and their assistants— often operate against the good intentions of management. "Regardless of individual intelligence, it is not to be expected that the employee, or even the foreman of a department, located constantly in one place in the factory and with attention concentrated on a small part of the complicated pattern of industry, can understand all matters without special training adapted to his needs. The chief executive will understand his problems far better after he tries to interpret them to his employees. Always be on guard against whims, personal indifference, laziness, and pride of opinion which too often influence decision.

"The most satisfactory way to prevent serious shortage of skilled labor is to train an adequate number of apprentices. This is a job for every employer. There must also be considered the matter of foreman training and advanced training for development of executives follows along this broad line of good management.

1. What evidence have you observed which indicates that your training programs produce the results needed in your plant?
2. What kind of training courses are your foremen taking in technical or business subjects, such as mathematics, drawing, engineering, business management, or economics, etc.?
3. How many of your foremen have been well enough trained to assume the responsibilities of the job above them? Is this number adequate to meet the needs of your plant?
4. What kind of apprentice training plan are you using in your plant? Why? How effective is it?
5. How many former apprentices who were trained in your plant are now employed by you as foremen?
6. What kind of advanced training do you use for the development of technical graduates? How effective is it?
7. Do you believe every member of your supervisory force is helping you to develop a general feeling that your plant is a good place in which to work? Just how have you reached this conclusion?

Methods of Payment Should Be Equitable

"Employer and worker alike are interested in the contents of the pay envelope, and therefore wages become a basic consideration. The method of payment should be equi-

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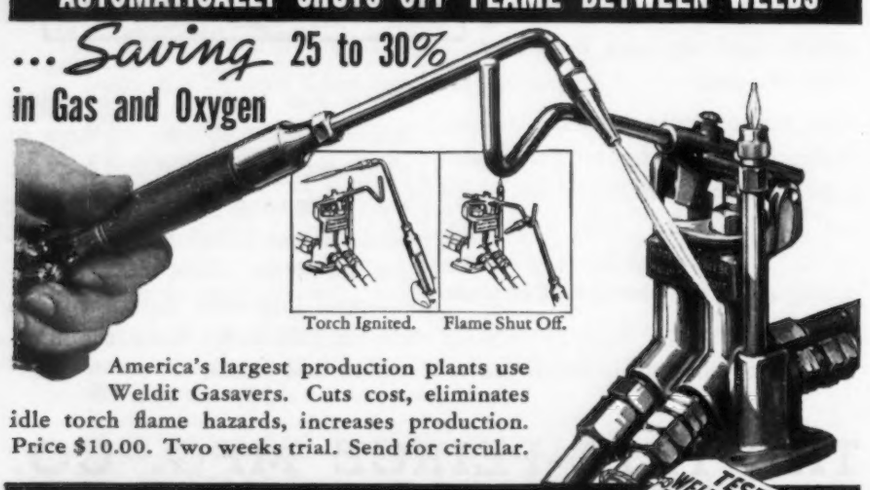

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table and the method of computation should be understood by the least intelligent person on the pay roll. Do not forget that workers are after all primarily interested in total annual income, and they are concerned with how much the wage will buy. The goal of modern management is to bring about the consistent, steady increase in real wages, with equally consistent, steady reduction in unit costs.

"Rate administration affects the welfare and contentment of an entire working force. Unless this part of the program is well handled the entire working force may look with justifiable suspicion upon all other activities of management.

"Try giving honest and full answers to some of the questions asked by the committee.

1. To what extent have you recently compared your wage payment plan with other plans?
2. How are the complaints and criticisms of your wage payment plan handled? How often do you check the service rendered by the individual who handles this work?
3. When you last compared your wage rates on different classes of employment with rates for the community, region or industry, what important inequalities did you find? What did you do about them?
4. How does your plan protect workers against the possibility of reduced earning power due to circumstances beyond their control?
5. Why do you believe your rate setters appreciate the human relations problems involved in their work?
6. How much do your foremen know about relative values of equipment maintenance as a means of decreasing overhead and increasing earnings?
7. What causes you to believe your wage payment plan on the whole promotes confidence and understanding between the employee and your executive organization, i.e., promotes a sound basis for management-employee cooperation?

"After having established fully effective contacts between management and the working force, and an educational program, and when methods and rates of compensation are accepted by the working force as being fair and adequate, then there will have been laid the firm foundation of industrial cooperation."

In a 58-page booklet, the Aluminum Co. of America, Pittsburgh, explains various aluminum finishes so as to assist users of aluminum in solving their finishing problems. Well illustrated, the publication includes discussions of the characteristics of aluminum, mechanical finishes, chemical dip finishes, electrolytic oxide finishes, electroplating on aluminum, alclad products and paint, lacquer and enamel finishes.

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of this disc type valve means reliable, positive control of air or hydraulic equipment. There is no packing—eliminating leakage and consequent maintenance troubles. Write for Valve Bulletin 34A.

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Republic Wire Mill Nears Completion

REPUBLIC STEEL CORP.'S new wire mill is nearing completion at South Chicago. Designed and constructed by the Austin Co., the mill is being built to accommodate high-speed crane, monorail and tramrail operations and employs glass block and other new acid-resisting materials in the cleaning house. It has been laid out for closely integrated production of a complete line of wire and wire products.

More than 100,000 cu. yd. of slag from Republic's slag dump, a quarter-mile distant from the wire mill site, have been used for the 9-ft. fill underlying 164,500 sq. ft. of concrete floors required in the five sections of this mill. Its concrete foundations rest upon a substrata about 12 ft. below floor level and were poured in patented plywood forms.

Fourteen hundred tons of steel were required for the project. A minimum thickness of 5/16 in. has been observed in steel in the outside crane runway building which accommodates the rod storage facilities. This section, 100 ft. wide and 200 ft. long, will be served by a 200-ft. railroad siding from which bundles of rods produced in the adjacent rod mill or other Republic steel-producing plants will be unloaded by one five-ton crane, with two hooks of 2½-ton capacity. The crane runways are designed for high speed, with special provision for impact and lateral stresses encountered in quick starting and stopping. The cranes will travel at a rate of 450 ft. per minute and will lift at a speed of 120 ft. per minute. As a safety measure, walkways are being built adjacent to the crane girders.

The cleaning department is to be served by cranes of the same type and capacity on a 40-ft. span. It has been provided with a steel of ⅜ in. minimum thickness and glass block is being used throughout the walls to provide light without the introduction of sash which would be subject to destruction by the corrosive acids employed in the cleaning and pickling process. Fifty-five hundred glass blocks 7¾ in. sq. and 3⅞ in. thick have been employed in this L-shaped cleaning section, which has a total area of 11,000 sq. ft. and lies between the rod storage and the wire-drawing departments. Its roof is made up of book tile, supported by structural Ts, which eliminate the need for reinforcement and are not subject to chemical reactions.

The wire drawing, process stor-

age, galvanizing and fence departments, which extend in a straight-line layout over a length of 675 ft., have a clear span of 100 ft.

Aiken-type monitors, with two high bays and one low bay in alternating sequence, are used throughout this section and the adjacent nail and warehousing departments. Walkways and ladders are being built over the roof to permit frequent cleaning of the monitors. Truscon Ferro Board 1¾ in. deep, covered by ½ in. of special insulating material, is being employed as roofing in these departments, which cover a total area of 132,000 sq. ft. Protected metal ventilators, 36 in. by 48 in., will be installed over the galvanizing room and in the cleaning department to insure an adequate air supply.

General Electric Co. Adjusts Earnings

A STABILIZATION plan whereby earnings of employees automatically increase as the cost of living rises has been announced by President Gerard Swope of the General Electric Co. The adjustments are to be made to conform with the index for the cost of living figures as published by the Department of Labor of the United States Government.

On that basis, effective Oct. 1, a cost of living adjustment of 2 per cent is being added to the earnings on the first $3,000 per year of all those receiving not exceeding $4,000 per year. The plan provides that if the cost of living goes up, corresponding increases will be made in employee earnings, up to a maximum of 10 per cent above the level when the plan was adopted, and when this point is reached the company will again give consideration to the question. If the cost of living decreases, adjustment will be made downward, but will not go below the standard of employee earnings in effect when the plan was adopted.

"The employees of several of our plants have requested an increase in wages," said Mr. Swope in announcing the plan. "Our most recent surveys of community rates at our various plants have shown definitely that we are living up to the company policy of paying at least as high as the community rates for occupations of comparable skill and efficiency.

"Moreover, although we are working shorter hours than in 1929, the average weekly wage of our employees has somewhat more purchasing value than in 1929 because living costs are lower than in 1929. As hours increase, up to the standard of 40 hr. per week, weekly earnings increase automatically, and in addition, as the company's profits increase, the amount available for distribution to employees as profit sharing also increases.

"During many recent negotiations with the representatives of our employees, complaints have been made that the cost of living was increasing. Cost of living has increased since the low point of 1933, but hourly rates and weekly earnings have increased even more rapidly.

"However, in order to allay concern on the part of the employees as to the rise in the cost of living, automatic increase in employee earnings will be made as the cost of living rises."

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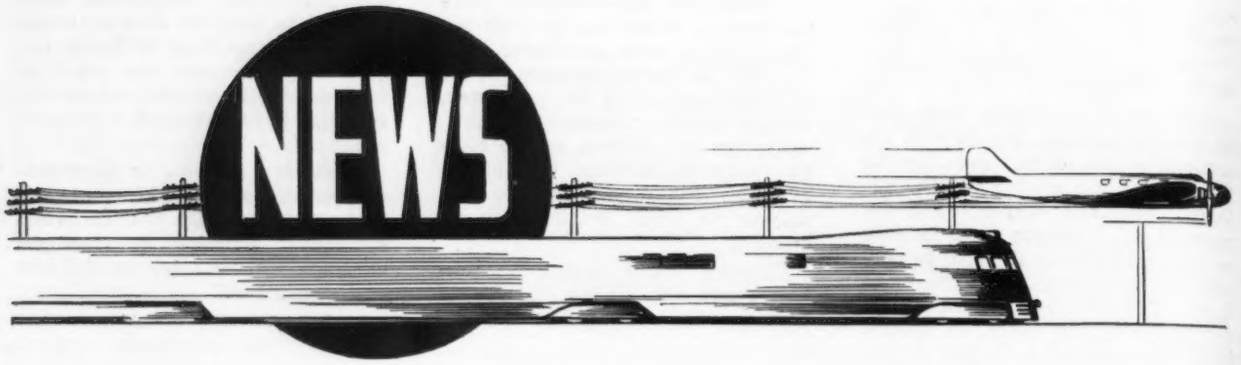

Steel Recovery Has Come Despite Obstacles, Says T. M. Girdler

IN an address before the Farm Equipment Institute at the Hotel Blackstone, Chicago, Oct. 7, on "Steel and the American Farmer," T. M. Girdler, chairman and president of Republic Steel Corp., said:

"At the present time operations in the steel industry are at a good rate. Business has been improving during recent months. It has improved in spite of many obstacles and uncertainties. It has improved in spite of open and furtive attacks that have been made on business and on the profit system. It has improved in spite of the heavy burden of taxes and bad and unfriendly legislation. It has improved in spite of the effort that has been made in this country to stir up class against class and to bring into disrepute the managers of industry who are responsible for the payrolls of millions of employees.

"The improvement in the steel business was inevitable in the face of the long period of under-production, which made necessary the eventual replacement of products and tools and equipment made of steel. In fact, improvement in some other parts of the world has gone farther than here.

"It is most encouraging that there has been some improvement in business generally, but it is not encouraging to discover that heavy industries are so slow in joining the upward trend and that building construction, which has always accompanied sound prosperity, continues so backward.

Uncertainties in the outlook still exist. Unless there is a return and a resurgence of confidence which will put idle capital to work, we cannot be sure how long the present momentum can be maintained.

Profits and Wages

"One of the serious problems facing steel today is to earn enough to pay a fair return to the people who have invested their savings in the industry.

"Management considered that its first obligation during the depression years was to labor. I do not believe that it is generally known that since 1933 wage rates in the industry, through adjustments of hours and increases in pay, have gone up more than 40 per cent. Total employment today is over 500,000 or some 48,000 greater than in 1929. Hourly rates are above the 1929 level, although weekly wages are somewhat less than they were at the peak of 1929, because hours of work are shorter. But weekly earnings are practically equal to that boom period in purchasing power, when the cost of living is taken into consideration.

"There has been much discussion recently about the subject of possible further wage increases in the steel industry. I am hopeful that the present improvement will be sufficient and continue long enough to enable us not only to increase wages, but to give a fair return to our investors as well.

"Industrial peace has existed in the steel industry for nearly 20

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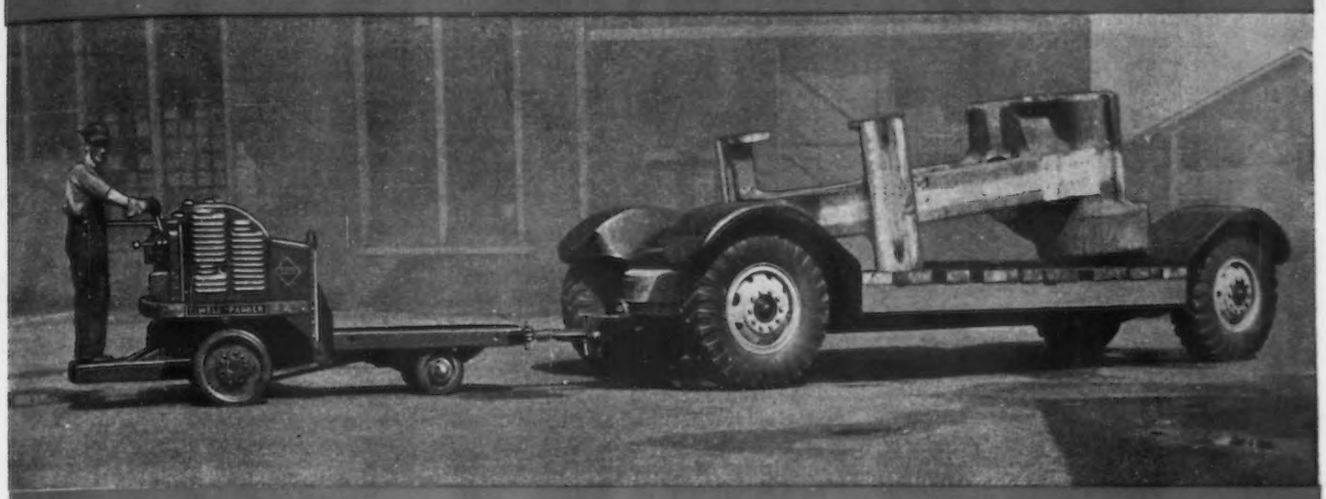
ANOTHER HEAVY JOB—*but*



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HERE is the plant yard of a nationally-famous builder of continuous strip mills and other heavy steel plant equipment. Here, too, are the Elwell-Parker Gas Lift Truck and suitable trailer with huge pneumatic tires. Elwell-Parker's abundant power negotiates heaviest inter-plant loads without visible effort.

Castings weighing 20 tons are loaded into trailer by overhead crane, and delivery to any other part of the plant is merely a matter of minutes and pennies, in spite of usual plant pavement conditions and variations in floor levels.

Formerly the Company spent $500.00 a month for transporting the same materials over the same routes —worse yet, it often waited 24 hours for delivery instead of 5 minutes as now.

The owners have other regular schedules of work to keep their Elwell-Parker profitably busy. It removes chips in high skid-boxes from beside lathes and other machine tools; scoots them into the yard and spots them in orderly rows until carloads have accumulated. It helps build up coal stock piles—even keeps shop yards scraped clear of snow in winter.

You try this: buy an Elwell-Parker for *one* job: you'll soon find it doing a flock of others—every one at a sizeable, separate profit. Now, with costs ballooning, you can make some deep cuts in materials-handling costs where perhaps your less progressive competitor *can't*.

Owners of older Elwell-Parkers, and those we've never served, are entitled to the services of a trained Elwell-Parker Engineer to make a survey of their plants, and are cordially invited to send for him now. No doubt he can help your own Engineers find new places where you, too, can realize major savings in transporting your loads.

The Elwell-Parker Electric Company, 4225 St. Clair Avenue, Cleveland, Ohio, *and branches.*

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years. During that period collective cooperation has become an established fact throughout the industry through the medium of employee representation plans. Through these plans problems both of the management and of the employees are fully and frankly discussed. The result is that management has a better and fuller understanding of the problems of the employees and I am sure that the employees understand better the problems of management.

"There are those who say that only trifling matters are handled by these employee representatives. But nothing could be further from the truth. In the first place, we consider no matter trifling or insignificant which concerns the safety and well-being of our employees. In the second place, if by describing the matters handled by the employee representatives as trifling, it is meant to convey that such considerations as wages are not discussed, then again the critics are wrong.

"During the first half of 1936, a survey of the operations of employee representation plans in the steel industry shows that the questions of wages and hours of work accounted for 40 per cent of the total items brought up by the employees. Fully 75 per cent of all questions arising under these plans in the industry during that period were settled in favor of employees.

"I mention these labor questions because they are of a very important concern to the farmer, to your industry and to all buyers of steel. Industrial peace is largely responsible for the ability of the steel industry to serve its customers at a fair price. Although wages in the steel industry for many decades have been consistently higher than the average wage for other manufacturing industries, steel prices have been free from the tremendous cost of labor disturbances."

Savings to Steel Users

Mr. Girdler said that in recent years the buying power for some important steel products purchased directly by the farmer has increased as much as 60 per cent. In 1929, for example, 100 lb. of beef at Chicago would have bought 407 lb. of barbed wire; in 1936, 521 lb.; or 418 lb. of galvanized sheets now as against 359 lb. in 1929. Likewise with wheat. In 1929 the farmer could exchange 10 bushels of wheat at Kansas City for 358 lb. of barbed wire; in 1929, 419 lb.; in 1929, 316 lb. of galvanized sheets against 336 lb. now.

"Apparently few realize," said Mr. Girdler, "that the steel industry has passed on in the form of lower prices the savings from technological advances made during recent years. Although hundreds of millions of dollars have been spent by the industry in new processes and new equipment, prices have declined an average of $11 per ton since 1923. This means a savings to American farmers of well over $25,000,000. The saving for all steel consumers in the country this year will be at least $300,000,000.

"I point out this fact and emphasize it because many have the mistaken notion that steel prices not only are fixed but are always at a high and excessive level."

Program for Meeting Of Steel Fabricators

THE fourteenth annual convention of the American Institute of Steel Construction will convene on Oct. 20, at the Greenbrier Hotel, White Sulphur Springs, W. Va., and continue in session for three days. The following special features have been provided:

Wednesday morning, Oct. 21: Addresses by C. G. Conley, president, and V. G. Iden, secretary. Reports of standing committee and appointment of special committees.

Wednesday afternoon, Oct. 21: Addresses by J. H. Van Deventer, editor of THE IRON AGE; W. S. Tower, executive secretary of the American Iron and Steel Institute; Thomas S. Holden, vice-president, F. W. Dodge Corp., New York; and A. P. Greensfelder, president of Fruin-Colnon Contracting Co., St. Louis.

Wednesday evening, Oct. 21: Moving picture of building of San Francisco-Oakland Bay Bridge by American Bridge Co. and lecture by C. F. Goodrich, chief engineer, American Bridge Co.

Thursday morning, Oct. 22: Report by F. H. Frankland, chief engineer. Address by J. R. Burkey, chief engineer of bridges, Ohio State Department of Highways, Columbus. Symposium on building codes.

Thursday afternoon, Oct. 22: Golf tournament.

Thursday evening, Oct. 22: Annual banquet, Clyde G. Conley, presiding. Speeches by Glenn Griswold, editor of *Business Week*, New York, and Frank Lovejoy, sales executive, Socony-Vacuum Co., Inc., New York.

Friday morning, Oct. 23: Reports by T. H. Hendrix, director of statistics, and Robert T. Brooks, executive vice-president. Speeches by W. N. Guthrie, of Stevenson, Jordan & Harrison, management engineers, New York, and Dr. Ralph T. Lee, department of pubic relations, General Motors Corp., Detroit.

Friday afternoon, Oct. 23: Unfinished business. Election of directors.

Friday evening, Oct. 23: Get-together dinner.

Saturday morning, Oct. 24: Joint session with the Robert Morris Associates at Hot Springs, Va. Discussion of a plan for credit survey and credit rating in the structural steel industry to be joined in by representatives of the banks and representatives of the American Institute of Steel Construction.

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Farm Equipment Industry Reports Satisfactory Year Despite Drought

FARM implement manufacturers, though cut short of expectations as established early in the year, are nevertheless experiencing a very satisfactory 12-month period. Farmer sales acceptance has improved in the past 18 months and it is still on the upgrade except where temporarily retarded by drought effects. Improved machinery, lower cost farm production, high prices and scarcity of used equipment, and the toll of wear and tear during four years of extremely lean purchases, are the impelling factors back of a revived market as reported before the Farm Equipment Institute at its Chicago meetings, held Oct. 7 and 8. The long-range outlook is excellent.

A real problem faced by the industry is to be certain that whatever governmental regulation is undertaken shall be wise and justifiable and not so restrictive as to interfere with normal and healthy development of business and industry, and it is the task of men engaged in business and industry to see that the common interests of all — customers, employees, and owners—are safeguarded from destructive interference, according to W. C. MacFarlane, president of the institute and president of the Minneapolis-Moline Power Implement Co.

Dependence of the industry upon agricultural prosperity was clearly demonstrated by H. G. Davis, director of research for the institute. In 1929, when cash farm income was $10,479,000,000, domestic implement sales were $458,000,000 at wholesale values. When farm income declined to $4,328,000,000 in 1932, sales were less than $120,000,000. With the recovery of prices for farm products, cash farm income increased to $7,090,000,000 in 1935 and wholesale sales in the domestic market rose to $301,000,000. In 1935 cash farm income was 68 per cent of 1929 income and wholesale farm equipment sales were 66 per cent of 1929 farm equipment sales.

While the 1936 drought, at the peak of its intensity, was as bad, if not really worse than was the one in 1934, its effects, even in the worst afflicted districts, are far less serious. This is due to a number of reasons. In the first place, the drought came later in the season and there is a larger supply of feed for livestock from early grain and hay crops which have been carefully conserved. In the second place, the decrease in the number of feed-consuming animals on farms materially reduces the demand for feed, and, in the third place, a substantial increase in farm income during the first seven months of the year, as compared to the corresponding period in 1934, puts farmers in a better financial position to meet adversity.

Cash receipts from the sale of farm products in the first eight months of 1936, according to estimates of the Bureau of Agricultural Economics, amounted to $4,472,000,000, or $697,000,000 more than the cash income for the first eight months of 1935. This is at the normal annual rate of $7,416,000,000. Governmental payments,

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PARISH PRESSED STEEL CO., Reading, Pa.

PACIFIC COAST REPRESENTATIVE
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SPECIALISTS IN STAMPINGS OF DISTINCTION

on the other hand, were only $205,000,000, as compared with $349,000,000 in the first eight months of 1935. The Bureau of Agricultural Economics estimates that total cash farm income, including governmental payments, for 1936 will be $7,850,000,000, or 11 per cent greater than the cash income of 1935. Such an income, coupled with fairly normal crop and weather conditions next spring, should result in good business in all lines serving farmers.

If the theory is allowed that parity between industries exists only when there is equal compensation for productive labor in the exchange of products, then the inevitable conclusion must be reached that the highest possible type of mechanization is necessary if agriculture is to exchange its products for those of other mechanized industries on a basis of parity. In order to get this equal compensation, however, the farmer must use his labor as efficiently as does the factory operator.

The 1935 census of farm equipment revealed an increased demand for power farming equipment. Tractors alone represented better than 40 per cent of total sales, while other equipment which is used with tractors carried the proportion to better than 50 per cent of the total business. There are several contributing factors to this change, among which might be mentioned (1) the introduction of the one-plow unit which opens a wide sales field hitherto untouched; (2) great improvements in tractors which make them more efficient and more adaptable to farm use; (3) the increased economy of tractor operations as compared to animal power; (4) the increasing favor power farming is meeting, and (5) the continuing decrease in horse and mule population.

The following officers have been elected to head the Farm Equipment Institute: C. R. Messinger, Oliver Farm Equipment Co., president; F. H. Clausen, Van Brunt Mfg. Co., reelected first vice-president; H. C. Merritt, Allis-Chalmers Mfg. Co., chairman of the executive committee; George L. Gillette, Minneapolis-Moline Power Implement Co., vice-president; George S. Hooper, George S. Hooper Co., member of the executive committee; and Z. W. Craine, Craine, Inc., member of executive committee.

In order to eliminate costly mistakes as far as possible and establish a better understanding between the gray iron foundry and its customer, the Gray Iron Founders' Society, Inc., has adapted the "Essential Information to Accompany Inquiries" from Volume XI, 1932, of the "Transactions" of the American Foundrymen's Association, to the special needs of the gray iron foundry. In addition, the society has assembled and bound for all of its members the A.S.T.M. specifications for gray iron.

Watson Sees Better Business Ahead

POINTING out that the characteristics of the present business situation—increasing public buying power, low stocks of goods and raw materials, ample funds and low interest rates—are directly opposite to those which prevailed before the 1929 crash, Thomas J. Watson, president, International Business Machines Corp., before sailing for Europe on the *Queen Mary*, said that the general outlook for further business advances this fall is most encouraging.

Warner & Swasey Co. Advertising Winner

WARNER & SWASEY CO., Cleveland, was awarded third prize for its entire 1936 advertising program by the National Industrial Advertisers' Association at its meeting in Philadelphia, Oct. 6. Business and trade paper advertising copy recognized by the award was built around the company's new "Industrial Dictionary" and specific performance achievements of the company's new high speed turret lathes. THE IRON AGE and other advertising media in the business and trade paper fields were the media used in the campaign.

As part of the company's advertising program for the year it conducted a direct mail campaign designated as "A Challenge to American Industry," for which the company was honored with an award as one of the three ranking leaders in the Direct Mail Advertising Association's 1936 competition. This award was presented at Cincinnati, Sept. 30, to H. W. Fortey, advertising manager of the Warner & Swasey Co., who directed the entire program.

Artistry, attention value and typography as well as copy appeal were taken into consideration in making these awards. It is significant of progress in industrial merchandising that a machine tool builder successfully competed with makers of consumer goods in the attractiveness of copy.

Results of tests of the strength of worn wire ropes at the National Bureau of Standards have been published in an article entitled, "Inspection and Tensile Tests of Some Worn Wire Ropes," in the September number of the National Bureau of Standards Journal of Research.

...OBITUARY...

HAROLD A. TOMKINS, president of the Tomkins-Johnson Co., Jackson, Mich., manufacturer of machine parts, died at his home in that city on Sept. 30, aged 68 years. Mr. Tomkins went to Jackson in 1911 from Oak Park, Ill., to superintend construction of the Jackson Motor Shaft Co. He organized the Tomkins-Johnson Co. in 1917. He was always prominent in the civic affairs of Jackson. At the time of his death he was treasurer of the Board of Education.

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A. W. GIFFORD, vice-president of Canadian Refractories, Ltd., Montreal, died at Salisbury, Conn., on Sept. 24. For many years he was a member of the firm of Wilson, Paterson, Gifford, Ltd.

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HENRY ELLSWORTH MORTON, president of the Morton Mfg. Co., Muskegon Heights, Mich., died at his home in that city on Sept. 29, aged 73 years. He had been identified with the company for the past 58 years.

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ADOLPH J. GAEHR, president, George Worthington Co., Cleveland hardware jobber, died on Oct. 5, aged 63 years. He started with the company 45 years ago as an office boy.

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WILLARD FULLER, formerly manager of the Upson Nut Co., now a unit of the Republic Steel Corp., died at his home in Chagrin Falls, Ohio, Oct. 4, aged 75 years.

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GEORGE D. OGDEN, who rose from station agent to assistant vice-president in charge of traffic of the Pennsylvania Railroad, died Oct. 4, at his summer home in Homer City, Pa. Mr. Ogden was born in Homer City in 1868 and started working as a station agent at the age of 18. After a series of promotions which moved him through increasingly important districts, including Pittsburgh, as freight agent, he became assistant general freight agent for the eastern division of the railroad in 1906, with headquarters in Philadelphia. In 1912 he became general freight agent, and eight years later was named vice-president in charge of the New England division. Last year he was appointed assistant vice-president in charge of traffic. In 1917, while in Pittsburgh, Mr. Ogden organized the Traffic Emergency Committee, to facilitate movement of war materials. He attended school at Indiana State Normal and at Washington and Jefferson College.

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ALONZO W. WHITCOMB, for many years associated with his father in the manufacture of planes and lathes by Whitcomb-Blaisdell Co., Worcester, until that firm was dissolved 15 years ago, died at his home in Worcester on Oct. 2. Mr. Whitcomb was born in Worcester 74 years ago, was graduated from Amherst College in 1884 and then became associated with the Worcester firm. When that firm dissolved he became associated with other machinery manufacturers until a few years ago when he retired.

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U. S. Steel Shipments High in September

SUBSIDIARY companies of the United States Steel Corp. shipped an aggregate of 961,803 tons of finished steel products in September, an increase of 38,100 tons over the preceding month and 346,870 tons above September, 1935. These were the largest shipments this year excepting May and April.

Based on the volume of shipments, the corporation's finished steel-making capacity was engaged during September at 62 per cent of capacity. This compares with a rate of 59.6 for the preceding month and 39.7 for September, 1935,

For the first nine months finished steel shipments amounted to 7,867,707 tons, against 5,341,223 tons in the same period of 1935, an increase of 2,526,484 tons, or over 47 per cent.

MONTHLY SHIPMENTS OF STEEL PRODUCTS BY UNITED STATES STEEL CORP.

Month	1933 Shipments	1933 Per Cent of Capacity	1934 Shipments	1934 Per Cent of Capacity	1935 Shipments	1935 Per Cent of Capacity	1936 Shipments	1936 Per Cent of Capacity
January	285,137	17.7	331,777	19.8	534,055	31.9	721,414	44.8
February	275,929	18.5	385,500	25.9	583,137	39.2	676,315	45.3
March	256,793	15.3	588,209	35.2	668,056	41.5	783,552	50.5
April	335,321	21.6	643,009	41.5	591,728	36.7	979,907	63.2
May	455,302	27.1	745,063	44.5	598,915	35.8	984,097	63.4
June	603,937	37.4	985,337	61.2	578,108	36.7	886,065	57.1
July	701,322	45.1	369,938	23.9	547,794	34.0	950,851	61.3
August	668,155	39.8	378,023	22.6	624,497	37.3	923,703	59.6
September	575,161	35.6	370,306	23.9	614,933	39.7	961,803	62.0
October	572,897	35.5	343,962	20.6	686,741	41.1	.....	...
November	430,358	26.7	366,119	22.7	681,820	42.3	.....	...
December	600,639	38.7	418,630	27.0	661,515	42.7	.....	...
Plus or minus yearly adjustment	(44,283)	...	(19,907)	...	.....	...	.....	...
Total for year	5,805,235	30.1	5,905,966	30.6	7,371,299	38.3	.....	...

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NAILS, RIVETS & SCREWS
NAILS, RIVETS & SCREWS MADE TO ORDER IN ANY METAL
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Du Pont Announces Zinc Plating Process

A MORE extensive use of zinc plating for production of attractive and durable rust-resistant surfaces on a wide variety of steel articles has been made possible through development, by the R. & H. chemicals department of E. I. du Pont de Nemours & Co., of an improved barrel plating process which uses a new brightening agent. It will be demonstrated publicly for the first time at the National Metals Exposition, Cleveland, Oct. 19 to 23.

The new process is claimed to be particularly adaptable to use in barrel plating of building hardware, radio parts, electrical fixtures and other metal equipment where attractive appearance is important. It is said to be quite resistant to finger staining.

A manual giving in detail methods for the application of sodium cyanide solutions in the preparation of metal surfaces also is announced by the R. & H. chemicals department. The manual gives a general outline for the various methods used in treating metal surfaces with specific information regarding the use and handling of sodium cyanide in that field.

Striking Employees Win Wage Advance

A 10-DAY strike of 130 employees of the American Steel Band Co., Pittsburgh, has been settled with wage increases of 5c. to 9c. per hr. and time and a half for Saturday and Sunday. The company's statement at the conclusion of the settlement does not indicate that it will recognize the Amalgamated Union as a sole collective bargaining agent but will recognize a workers' committee regardless of the make-up.

A.F.A. 1937 Meeting In Milwaukee

MILWAUKEE has been selected for the forty-first annual convention and exposition of the American Foundrymen's Association, to be held during the week of May 2, 1937. The meetings and display of equipment and supplies will be staged in the Milwaukee Auditorium.

National Founders To Meet Nov. 18-19

THE annual meeting of the National Founders Association will be held Nov. 18 and 19, at the Waldorf-Astoria Hotel, New York. J. M. Taylor, 29 South La Salle Street, Chicago, is secretary-treasurer.

This Week on the Assembly Line

(CONTINUED FROM PAGE 223)

122 in. Brakes are of the cable controlled mechanical type, as in last year's car.

Four body types are available this year, including a four-door sedan, two-door sedan, a new three-passenger coupe and a town limousine, which was added to the line early last summer. As has been anticipated, a marked reduction in price has been announced. Base price on the three-passenger coupe is $1,090, and on the two-door sedan, $1,170. Last year the base price in the introductory series for the two-door sedan was $1,275. With 15,000 cars already on the road, Lincoln-Zephyr is looking forward to a much bigger showing this year with its lower prices and advanced styling.

Graham-Paige is coming out with three six-cylinder models, all in the lower-priced class, which will supplement their Crusader Six, which is continued unchanged. New lines comprise the Cavalier, the Graham Supercharger and the Graham Custom Supercharger, all on a 116-in. wheelbase, besides a new supercharged 120-in. wheelbase chassis for sedan models. The front end appearance of the Graham has been changed materially, although the lacquered sheet metal strip is still maintained down the center of the grille. This center section is swung back along the top of the hood in a corrugated panel. Front fenders are of a somewhat deeper draw than last year and the windshield has a sharper "V" and wider opening for better vision. As in most of the cars being offered this year, there is a defrosting unit which is integral with the instrument board. Two molded Tenite orifices aim streams of heated air against the glass. Graham also has this year probably the largest molded instrument panel, which is also made of Tenite. It does not include either a speedometer or clock, which are set on either side.

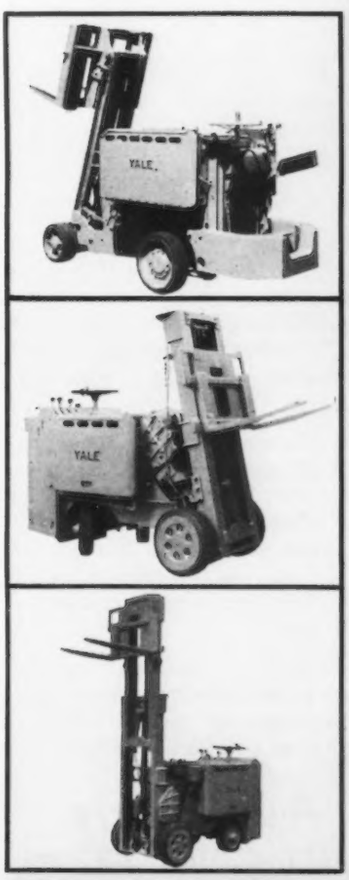
Particular attention has been directed toward refinements in the engine. All engines have aluminum heads and a compression ratio of 6.7 to 1, whether supercharged or not. Bohn Autothermic aluminum pistons are used, elliptically ground and plated with a tin-base bearing alloy. The most novel feature is a system of lubricating the skirt of the piston through ports in the cylinder side wall which are uncovered periodically by the motion of barrel-type valve lifters. A groove around the piston skirt distributes oil entirely around the cylinder wall. By this method of lubrication, the quantity of oil is actually reduced at higher speeds instead of being increased, as in the ordinary splash system. The connecting rod has also been changed. The caps are held by set screws threaded into blind holes and this construction eliminates the under-cuts necessary to provide room for bolt heads. Actually the rod is 2 oz. lighter and twice as strong as the previous one. Exhaust valves have been improved due to the use of higher chrome and nickel content in the valve material and the use of a new extrusion method of forging.

Drive of the supercharging unit is now by dual V-belt with tension automatically controlled and a slack take-up incorporated. This supplants the former chain drive. Over-drives are offered this year

THEY LIFT
THEY HAUL
THEY STACK

and cut handling costs UP TO 80%

YALE TILTING FORK TRUCKS



HOW are these economies effected? By the speed and efficiency with which materials are lifted and moved from one process to another. This means faster, greater production in less time and at lower cost.

Yale Fork Trucks pick up pallet and unit loads of all types, transport them in safe tilted position through narrow aisles and around sharp turns to their destination and there stack them, increasing storage space by making higher spaces easily accessible and useable.

Get the complete economy story of Yale Tilting Fork Trucks. The nearest Yale representative is no further away than your telephone.

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as optional equipment. This unit is mounted in a separate case attached to the rear end of the transmission. A new needle-bearing ball-type universal joint made by Universal Products is standard on all models. This propeller shaft has no spline or slip joint and is rigidly piloted at each end. Steering has been improved by the use of a two-stud cam-type steering gear similar to the one used on Studebaker's 1937 models. Front end articulation has been improved also. The front spring rate has been lowered by about 15 per cent to reduce the frequency of spring oscillation and give a more comfortable ride. Hydraulic brakes are continued.

American Bantam in Light Car Field

The American Bantam Car Co. is making a play for the light delivery field in a line of cars just announced. F.O. B. prices run from $275 for the ¼-ton truck chassis up to $445 for a custom-built roadster. Harry Miller, famous on the race track, has designed the four cylinder motor which has a block of heat-treated alloy iron. The crankcase is of aluminum, pistons are of cast nickel alloy steel with Nitralloy wrist pins, and the crankshaft is of nickel alloy steel, statically and dynamically balanced. The camshaft is made of the same material. This engine, with a bore of 2.2 in. and a stroke of 3 in. develops 20 hp. at 4000 r.p.m. Gasoline economy of 45 to 50 miles per gal. is claimed. Already the company has dealer orders for over 20,000 of the new units, which are very conservative in line as far as body appearance is concerned.

C.I.O. Establishes Detroit Office

Tom Jones, veteran organizer and international representative for the United Mine Workers, has come into Detroit to head up John L. Lewis' drive to unionize steel workers in this area. As representative of the Committee for Industrial Organization, Jones has established an office in the international headquarters of the United Automobile Workers in the Hofmann Building, Detroit, which is also backed up by the C.I.O. Jones estimates that there are 77,000 eligible workers in steel mills and steel-working plants in Detroit, Ecorse, Wyandotte, River Rouge and Monroe. Before coming to Detroit, Jones was international representative of the United Mine Workers, with an office at Jellicoe, Tenn. He will cooperate with Adolph Garmer, another United Mine worker and representative of C.I.O., who is advising the U.A.W. on their drive to organize workers in the automotive industry.

New Machinery Company

Partool Machine Co., New Center Building, Detroit, has been formed to build special machinery for the automotive industry. Plans are under way to construct a building 90 x 150 ft., which is scheduled to be in operation by Jan. 1. Charles E. French is president of the company, which is capitalized at $100,000. Sterling-French Machinery Co., Detroit, will handle the sales of the product.

New Mask for Abrasive and Dust Resistance

MINE Safety Appliance Co., Pittsburgh, has announced the MSA abrasive mask, a recent development of Dust Research Laboratories. Light in weight and comfortable to wear, the unit is capable of giving complete protection to the wearer from the heavy concentrations of fine dust present in shot and sand-blasting rooms. It is constructed to withstand the impact of high-velocity abrasives, to supply the protective efficiency, and to possess durability.

Air is fed into the face-piece through a corrugated rubber tube which permits free movement of the head. The incoming air enters the lower part of the face-piece and passes out through double exhalation valves. Extremely low resistance to the air flow permits low pressure in the face-piece and assures an ample supply of air. The hood is of latex-covered silk construction, low in weight although tough and resilient to impact. It fits over the head and shoulders and fastens at the waist, exposing only the lens section of the face-piece.

The mask has a flow control valve with a "bump-proof" adjustment. The setting cannot be changed accidentally, since the handle is normally held in a released position by means of a spring which must be pushed in by the operator to an engaged position, and then turned to change the flow of air. In the event of air failure or unfitness, for any cause, a lever extending over the air supply nipple of the flow control valve immediately detaches the mask from the air line through an upward pull by the operator. This enables breaking of the connection and breathing through the filter on the free end of the corrugated tube.

DeVlieg Milling Machine Co., Curtis Building, Detroit, has appointed J. C. Whitney Machinery Co., Rockefeller Building, Cleveland, as distributer in that district.

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ELIMINATE costly repairs and "shut-down" worries caused by sudden overloads on your machinery.

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E. R. Stettinius Stresses Need For Developing Executives

SPEAKING before the Harvard Graduate School of Business Administration recently, E. R. Stettinius, Jr., chairman of the finance committee of the United States Steel Corp., stressed the need for a more scientific and orderly search for and training of executives. The address was opened with the statement that, "of course, the quest for leaders is as old as the race. But that quest is more active today than ever before in our industrial history. This, I think, is chiefly because many new problems have arisen to create a crying need for a new type of business leader and the efforts in many organizations to find such leaders are numerous.

Mr. Stettinius went on to point out that from the countless millions within and outside the doors of business, it would seem that an industry has only to pick and choose. But when, behind the scenes, the business man is confronted with any great or intricate problem of organization, he is certain to be perplexed by the scarcity of men capable of serving as leaders. There are men in great plenty. The difficulty is to find the man—the man who can be depended upon to cope successfully with the many problems, governmental as well as social and economic, with which business and notably industry is confronted today.

However, to Mr. Stettinius the crux of the situation seemed not so much the need for men nor the scarcity of proven leaders as it is the failure of American business management generally to introduce an orderly and methodical system for the discovery, development and assignment of executive personnel. Heretofore industry has gone on the theory that the men needed—the leaders of today and tomorrow—are automatically available among the millions in industry.

"But how incomplete," continued Mr. Stettinius, "and how largely fortuitous are the catch-as-catch-can methods that business all too frequently employs to find them! We practical men called business men have all along taken it for granted that we *could* find them; we have felt that by their genius and determination they would open closed doors—that the door of opportunity would somehow find them on its threshold; that the need would bring forth the men."

The speaker proposed no magic formula for the development of executives, but he did stress the fact that the problem could be approached in a more scientific fashion. Mr. Stettinius would recommend that there be established, under the president, an officer in charge of executive personnel. This individual should be intimately acquainted with the traditions and aims of the enterprise and he must possess great human understanding, derived from a background of broad industrial experience. The importance of selecting a properly qualified individual to head up this activity cannot be stressed too strongly; for upon him chiefly will depend the success or failure of the program.

The responsibilities and duties of such an executive officer would be something along the following lines:

First, to maintain a complete, progressive record of all employes, actually or potentially eligible for rating as executives. Among other things, the record should include the individual's educational history; his record of employment before joining the organization and with his present employer; a complete salary record; a periodic systematic rating by his immediate superiors and the executive personnel officer; a detailed description of his physical characteristics and social status, as well as a health history cur-

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rently maintained by periodic physical examination.

Second, to maintain organization charts on which would be registered all eligible executives qualifying for this special analysis.

Third, to develop lines of promotion whereby opportunities for advancement would be company-wide in every department of the business.

Fourth, to prepare and maintain job specifications for all positions on a specially prepared organization chart and to insure that qualified understudies are in training for promotion to those positions, such selection to antedate by as long a period as possible the actual promotion.

Fifth, to make available information concerning courses of study, books, periodicals and other activities of an educational nature.

Sixth, to evaluate each position through the use of job analysis and specifications as the base for a salary standardization plan.

Seventh, to serve as secretary of a salary committee composed of an appropriate group of principal executives as a further application of the salary-standardization plan.

Finally, to act as fact-finder and adviser to the president and other principal executives in all matters pertaining to executive employment, compensation, advancement, retirement, and the like.

This new office must necessarily be an activity separate and apart from the usual industrial relations function, but it is obvious that the two must be thoroughly synchronized, especially in such matters as recruiting of college graduates, general training and rating programs and the like.

The activities of the executive personnel officer should not be confined exclusively to members of the organization. He must also go afield to widen his contacts throughout all industries for purposes of discovering eligible talent.

U. S. Building Only 4 Per Cent of Ships

MORE than 2,100,000 gross tons of merchant vessels of 100 tons each and upward are now being built throughout the world, says a statement by Lloyd's Register of Shipping, covering returns for the quarter ended Sept. 30, from all maritime countries except Russia.

The total shipping now under construction represents an increase of 160,000 gross tons over the aggregate reported at the end of the previous quarter, June 30 last. Gains are reported for Great Britain and Ireland, Germany, Japan, the United States, Denmark and France, while declines are shown in the production of Holland, Sweden, and Italy.

As against an advance of 79,000 gross tons for Great Britain and Ireland, the gain reported for the United States was less than 1000 tons; while the other countries, taken as a group, showed an increase of about 80,000 tons. Lloyd's Register shows the comparison in the production of these countries in the last two quarters, in the following table, the figures representing gross tons:

	Sept. 30 1936	June 30, 1936
Great Britain and Ireland	928,571	848,732
United States	90,960	90,275
Other countries	1,091,926	1,011,998
World total	2,111,457	1,951,005

Approximately 44 per cent of the entire current production is being built in Great Britain and Ireland, as compared with slightly over 4 per cent in the United States, and about 52 per cent in the other countries.

Cold Metal Process Completes New Plant

COLD METAL PROCESS CO., Youngstown, has completed a new plant to replace the one that was recently destroyed by fire. This is located in a building 100 x 600 ft. formerly occupied by the Sharon Steel Hoop Co. The company has installed a 7½-in. and a 14-in. Steckel single stand reversing cold strip mill and is installing a similar 26-in. mill. The part of the plant not used for the production of steel has been equipped for the manufacturing department.

Steel Castings Orders Decline

ORDERS for commercial steel castings in August declined to 59,393 tons from 74,011 tons in July. In the first eight months of the current year orders totaled 556,948 tons against 262,366 tons in the corresponding period last year.

Production in August rose to 81,574 tons from 78,654 tons in July. In the first eight months of the current year output was 501,810 tons compared with 247,022 tons in the corresponding period of 1935.

Bethlehem Steel Co. was low bidder on the fabricated portion, 239 tons, of 900 tons of steel bearing piles and accessory structural material for rebuilding the naval station at Key West, Fla. Bids were opened last Wednesday in Washington. The Carnegie-Illinois Steel Corp., and Bethlehem tied on bids for 668 tons of plain shapes while the former was low bidder on 10 tons of plain material.

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..PERSONALS..

GEORGE H. BUCHER has been elected executive vice-president of the Westinghouse Electric & Mfg. Co., with headquarters at Pittsburgh. Mr. Bucher is also president and general manager of the Westinghouse Electric International Co.

Mr. Bucher has been connected with the Westinghouse organization since Sept. 1, 1909. After graduating from Pratt Institute, Brooklyn, in both steam and machine design and also electrical engineering, Mr. Bucher joined the Westinghouse Electric & Mfg. Co. at East Pittsburgh as a graduate student. In 1911 he was transferred to the export department in New York. In 1920 he was appointed assistant to general manager of the Westinghouse Electric International Co. and a year later he was made assistant general manager, which position he held until 1932, when he was elected vice-president and general manager. In 1934 he was elected president and general manager of the same company and in 1935 vice-president of the Westinghouse Electric & Mfg. Co.

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CHARLES F. SCOTT, professor emeritus of electrical engineering at Yale University, was reelected chairman of the Engineers' Council for Professional Development at the fourth annual meeting of the council, held in New York on Oct. 6.

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A. R. O'NEAL has been appointed manager of a new district office of the Linde Air Products Co., New York, at 2 Virginia Street, Charleston, W. Va.

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J. HARRY CHRISTMAN, heretofore sales manager and a vice-president of the Milcor Steel Co., Milwaukee, has been made manager of the company's Chicago plant. He has been identified with the company since 1913 and has been sales manager since 1918.

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P. A. HILL, at one time with the Superior Steel & Malleable Castings Co., has become associated in a sales capacity with the Belle City Malleable Iron Co. and the Racine Steel Castings Co., both of Racine, Wis.

E. C. BULLARD, vice-president and general manager, Bullard Co., Bridgeport, Conn., sailed Oct. 1 for

EDWARD C. BULLARD

an extended business trip through Europe. He plans to visit Sweden, Russia, Germany, France, England and other countries, and to return about the middle of December.

BENJAMIN SCHWARTZ, director general of the Institute of Scrap Iron and Steel, is to be the principal speaker at the Nov. 19 meeting of the Detroit chapter of the American Foundrymen's Association. His subject will be "Integrity—the Essential Ingredient in the Foundry."

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E. H. HART, J. N. SWARR, K. J. PLATT and R. A. BARNES have been assigned respectively to the Boston, New York, Philadelphia and St. Louis offices of the Bristol Co., Waterbury, Conn., as service engineers. They have just completed a two-month training course at the factory.

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CHARLES G. THOMA, formerly advertising and sales promotion manager for the Firth-Sterling Steel Co., has joined the staff of Sheldon, Morse, Hutchins & Easton, Inc., advertising and public relations counsel, New York.

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H. S. DERSHIMER has been appointed Tulsa, Okla., district sales

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manager, with office in the Philtower Building, for the Babcock & Wilcox Tube Co., Beaver Falls, Pa. REID R. LUMSDEN has been placed in charge of the Dallas, Tex., area, with headquarters at 728 Wilson Building, and O. E. BERG, at 1007 Electric Building, Houston, Tex., will cover the Houston section.

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WILSON MILES CARY, JR., formerly associated with the Jeffrey Mfg. Co., Columbus, Ohio, is now with the Pittsburgh Screw & Bolt Corp. in a sales capacity, and will be located at its New York office at 630 Fifth Avenue.

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E. M. PRIOR, who recently became Chicago representative for the Rotary Electric Steel Co., Detroit, will also continue to represent the Pressed Steel Co., Wilkes-Barre, Pa., for which he has been Western representative for some time.

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JAMES Y. SCOTT, general manager of the Van Norman Machine Tool Co., has been made executive vice-president and treasurer, as well as general manager. LEO F. HUNDERUP has been made assistant general manager. Mr. Scott has been with the company for more than 20 years.

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FRANK N. SATTER has been made district manager in charge of sales in the Cleveland-Youngstown district by the Lawrenceville Bronze Co., Pittsburgh, Pa. He will have his office at 3030 Euclid Avenue, Cleveland.

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FRANK P. MCEWEN, formerly Southern sales manager of the Oliver Iron & Steel Corp., has been appointed assistant manager of sales, with headquarters in Cleveland, of the Upson bolt and nut division of the Republic Steel Corp.

F. P. McEWEN

He has spent the major part of his business life in the railroad field, his first connection having been in the freight department of the Nashville, Chattanooga & St. Louis Railroad. He resigned from that company in 1912 to become identified with the Clinchfield Railroad. After spending 14 months in France in war service, he returned to the Clinchfield Railroad as general Western agent. Mr. McEwen became district sales manager of the Oliver Iron & Steel Corp. in 1928.

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H. H. CLEVELAND, for 24 years with the Billings & Spencer Co., Hartford, the last five years in the position of general sales manager, has become associated with Bonney Forge & Tool Works, Allentown, Pa., manufacturer of wrenches, tools, drop forgings and welding fittings. Mr. Cleveland will take charge of all tool sales in the industrial, hardware and mill supply fields.

E. J. ANGLIN, vice-president in charge of operations, Weirton Steel Co., whose appointment was announced in these columns in the issue of Sept. 10.

A. R. PFELTZ, who has been manager of manufacturing of the American Can Co. for some years, has been appointed vice-president in charge of purchasing and traffic.

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LAWRENCE V. CALHOUN has joined the organization of Erman-Howell & Co., Chicago, brokers of scrap iron and steel. Mr. Calhoun was formerly associated with Pettibone-Mulliken Co., Chicago.

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JOSEPH T. SOMERS, formerly vice-president of Wyckoff Drawn Steel Co., has been appointed president, succeeding the late Col. A. W. Wyckoff. Mr. Somers has been active in the management of this company since its formation in 1919.

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HANSON THOMAS, who was until recently vice-president and general manager of the Oliver Iron & Steel Co., Pittsburgh bolt and nut manufacturer, has become associated with the sales department of Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.

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Plans Development Of Electric Welding

REALIZING the need for co-operative development of the industrial applications of the electric welding process, the electric welding section of the National Electrical Manufacturers Association has established development headquarters in the Frick Building, Pittsburgh.

The welding section has initiated a program of cooperative industry development, to investigate the electric welding market and determine the possibilities of extending it. In this program special attention will be given to application engineering, including:

The preparation of reliable information on cost savings through the use of electric welding.

The preparation of material for the use of and cooperation with

H. S. CARD

construction engineers, designers and architects.

The direct promotion of electric welding by missionary work on important new or undeveloped applications.

H. S. Card, formerly editor of *The Welding Engineer* and author of "The Welding Industry," has been appointed development director of the N.E.M.A. electric welding section and will be in charge of the Pittsburgh office.

Industrial Truck Casters

THE Bond Foundry & Machine Co., Manheim, Pa., announces a new line of anti-friction industrial truck casters featuring Hyatt roller bearings in a standard assembly. The line is in production in both the Manheim and Canadian plants of the Bond Co.

Railroad Equipment Buying Increases

AMERICAN railroads ordered 24 locomotives and 3100 freight cars in September, which brought the total orders for these two types of equipment for the nine months so far this year to nearly double that for the same items in the entire year of 1935, according to *Railway Age*. Last year only 83 locomotives were ordered, while thus far in 1936, orders have been placed for 158. The 122 steam locomotives which have been ordered this year are equal to all those ordered in the years from 1932 to 1935 inclusive.

"Thus far in 1936 a total of 37,354 freight cars has been ordered for domestic service," says the publication. "This is but 44 cars short of being double the business of the entire year 1935, when domestic orders for 18,699 freight cars were placed, and is 80 per cent as large as the total orders placed in 1930."

Compact Electric Band Saw Brazer

AN electric brazer for band saws up to 1½ in. wide is being marketed by Grob Brothers, West Allis, Wis.

A transformer is mounted in the base. The secondary coil has extensions through the top of the cover which provide for clamping and proper alinement of the saw band ends. A center clamp for pressing the ends together when brazed is operated with a handle. A switch is connected with various windings of the primary coil and provides three different heats.

The brazer is made for either 110 or 220 volts ac. single phase 60 cycle. The net weight is 50 lb.

Copper Plate Solution For Hardening Use

KWIK-COTE copper plate solution, marketed by Grapho Products, Inc., 2232 Alvord Street, Indianapolis, Ind., is applied by dipping or with a small stiff brush. Hair-line separation of hardened areas is said to be secured by careful covering of areas to be kept soft. The solution is said to dry quickly permitting immediate carburization. Utility is particularly specified for bores to be kept soft for reaming after heat treatment.

"HOLD THE LINE, PLEASE—OUR BLOODHOUNDS ARE TRACKING HIM DOWN"

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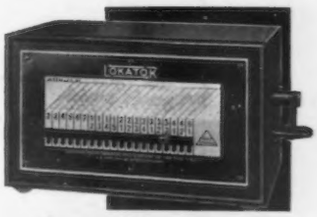

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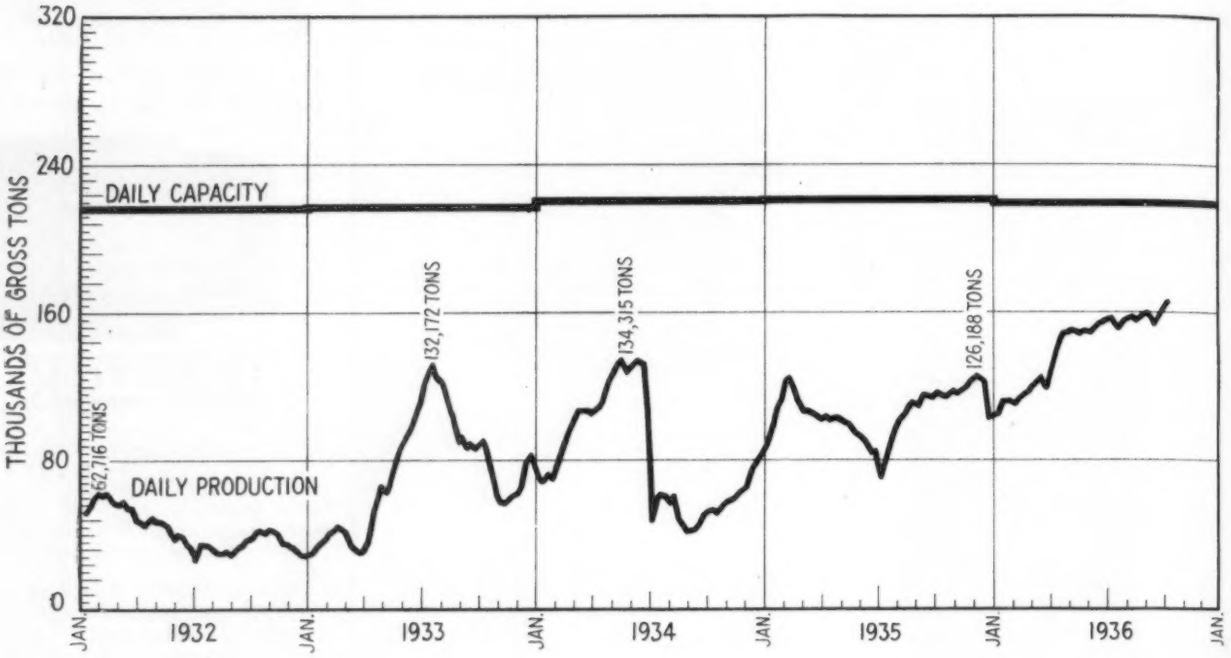
STEEL INGOT PRODUCTION

Daily Tonnage of Bessemer and Open-Hearth Steel Ingots Produced by Weeks, 1932-1936

Current Week	Last Week	Weeks Ended Oct. 19, 1935	Oct. 20, 1934	Oct. 21, 1933	Oct. 22, 1932
164,605	165,702	115,118	51,744	80,170	42,171



STEEL INGOT PRODUCTION BY DISTRICTS: Per Cent of Capacity

District	Current Week	Last Week	Weeks Ended Sept. 19, 1936	Oct. 19, 1935	Oct. 20, 1934
Pittsburgh	76.0	76.0	70.0	45.0	16.0
Chicago	76.0	76.0	73.0	55.5	24.0
Valleys	76.0	79.0	76.0	56.0	28.0
Philadelphia	55.5	55.5*	55.0	40.0	22.0
Cleveland	78.0	80.0	74.0	61.0	26.0
Buffalo	78.0	80.0	75.0	46.0	24.0
Wheeling	96.0	97.0	95.0	80.0	23.0
Southern	60.5	60.5	60.5	54.0	25.0
Ohio River	95.0	94.0	85.0	81.0	20.0
Western	59.0	59.0	70.0	35.0	15.0
St. Louis	72.5	72.5	69.0	60.0	25.0
Detroit	95.0	95.0	100.0	90.0	76.0
Eastern	90.0	90.0	90.0	35.0	20.0
Aggregate	75.0	75.5	72.0	52.0	23.5
Average Year to Date	65.1	64.9	64.1	46.8	38.9

* Corrected

Weekly Booking of Construction Steel

FROM THE IRON AGE

	Week Ended Oct. 13, 1936	Oct. 6, 1936	Sept. 15, 1936	Oct. 15, 1935	Year to Date 1936	1935
Fabricated structural steel awards	14,400	13,900	20,540	5,400	859,230	610,685
Fabricated plate awards	6,415	2,625	1,415	1,650	179,215	115,035
Steel sheet piling awards	2,545	0	0	0	44,720	54,010
Reinforcing bar awards	4,300	4,555	2,770	3,415	283,230	259,240
Total Lettings of Construction Steel	27,660	21,080	24,725	10,465	1,366,395	1,038,970

. . . .SUMMARY OF THE WEEK. . . .

. . . Steel companies' backlogs growing in some products.

o o o

. . . Ingot output off slightly, mainly due to repairs.

o o o

. . . Heavy melting steel scrap 25c. a ton lower at Pittsburgh.

STEEL ingot production is a half-point lower this week at 75 per cent of capacity, but the decline is without special significance, having occurred in some districts through the necessity of taking off open-hearth furnaces for repairs. Backlogs of the steel companies in most products are still growing. In fact, the aggregate amount of buying in the first part of October is equal to that of the corresponding period in September, though there has been a falling off this month in those items that were advanced in price for the fourth quarter, notably carbon bars and light-gage hot-rolled annealed sheets.

In sheets and bars some mills have practically all of the tonnage on their books that they can furnish in this quarter. As evidence that sheets are going rapidly into consumption, some customers have requested earlier deliveries than were originally specified. With automobile companies swinging into larger production schedules, consumption of sheets will be materially increased during the next month. It now develops that many users of these products, in placing orders last month, did not look far enough ahead and are making additional purchases as a protection against further delays in delivery later on.

Shortages are accumulating in several directions. For example, some steel companies that have been selling coke for domestic uses in the past few years have had to curtail sales for that purpose because of their own requirements, which has resulted in larger shipments of coal and a consequent scarcity of open top cars. Larger shipments of pig iron to foundries together with the fact that coke scarcity is placing a limit on merchant pig iron production, point to a possible shortage of pig iron this winter, though stocks are ample for the present. Higher pig iron prices are a possibility within the next 30 days.

RAILROAD equipment buying is gaining headway, as steadily increasing carloadings point to the necessity of rehabilitation of rolling stock and motive power. The Boston & Maine has ordered 10 large locomotives, the Union Pacific is inquiring for 20 and the Wheeling & Lake Erie for 10. The Baltimore & Ohio will recondition 100 locomotives. The Gulf, Mobile & Northern is inquiring for 250 freight cars, the Rock Island for 350, the Kennecott Copper Co. for 240 large ore cars and the Bethlehem Steel Co. is building 100 cars in its own shops. The Rock Island may also buy six streamlined passenger trains of three or four cars each.

The largest pipe line order in several months, amounting to 30,000 tons of 10-in. seamless pipe, has been placed by the Gulf Oil Corp., two-thirds going to National Tube Co. and one-third to Jones & Laughlin Steel Corp.

Building construction, as reflected in steel lettings, is not setting a brisk pace, but the more frequent appearance of private projects among the Government-financed jobs offers some encouragement. New projects include 4300 tons for a section of the Sixth Avenue subway, New York, and 3000 tons for an ice breaker for the State of Michigan. American Bridge Co. will build 25 coal barges, requiring 3800 tons of steel, for its affiliate, Carnegie-Illinois Steel Corp.

The automobile industry will not be in full swing on new models until late this month or early November, but output was sharply higher last week. Ford Motor Co., it is reported, will assemble 225,000 units before Dec. 10.

A LARGER supply of scrap is easing the tension that has steadily increased prices since June. Heavy melting steel is down 25c. a ton at Pittsburgh, resulting in a decline of 8c. a ton in THE IRON AGE composite price to $16.67.

. . . PITTSBURGH . . .

. . . New business less in some products but holding up well in others.

o o o

. . . Heavy backlogs will sustain present production for some time.

o o o

. . . Heavy steel scrap supply easier and price is reduced 25c.

PITTSBURGH, Oct. 13.—Ingot output in the Pittsburgh district is unchanged at 76 per cent of capacity, while operations in the Wheeling district have dropped one point to 96 per cent. Mill backlogs are sufficient to maintain operations around current levels for at least the next three weeks.

Specifications at fourth quarter prices on hot-rolled and cold-finished bars, hot-rolled annealed sheets and wire products have been light, but this was expected by producers in view of the heavy tonnages placed last month. Heavy products have fared a little better over the past week. Specifications for plates have improved. American Bridge Co. will use about 3800 tons of plates and shapes in constructing 25 coal barges for Carnegie-Illinois Steel Corp.

An outstanding feature of this week's market is an order for around 30,000 tons of 10-in. seamless line pipe for Gulf Oil Corp., Pittsburgh. One-third of the order went to Jones & Laughlin Steel Corp., while the remainder will be fabricated by National Tube Co. This pipe will be used for loops in the company's oil line running from Jenks, Okla., to Dublin, Ind., and is the largest single line pipe order in several months.

The Jones & Laughlin Steel Corp. will furnish 475 tons of steel sheet piling for a dam project on the Allegheny River at Braeburn, Pa., while Carnegie-Illinois Steel Corp. will fabricate 890 tons of piling for a sewage disposal plant at Buffalo.

Production of hot-rolled carbon bars is at practical capacity and there has been an increase in the number of orders for alloy bars. Sheet specifications have eased off in the past week, but production is being maintained at a high rate owing to heavy backlogs. Consumers of hot and cold-rolled strip steel are specifying freely and orders are better than shipments. Tin plate production continues at the unseasonably high rate of 90 per cent. New specifications have been falling off within the past few weeks, but the present rate is being sustained by mill backlogs.

Demand for pig iron continues to improve and with the heavy consumption, both by the merchant trade and steel works, coupled with the tight situation in coke, there is a possibility of a shortage in the near future. Meanwhile, opinion in this district is almost unanimous that an increase in price will materialize within the next month or so. Blast furnace relining and open hearth and soaking pit repairs are responsible for a steady flow of orders for refractory material.

No. 1 heavy melting is off 25c., reflecting a slightly easier situation.

Pig Iron

Demand continues to improve. Assuring themselves protection in case prices advance, many large consumers in this area have contracted for their requirements over the remainder of this year. Quite a few orders involving substantial tonnages have been placed. Opinion is almost unanimous that a price advance will materialize within the next month or so. With merchant consumption increasing and open hearths requiring greater percentages of iron, not only because of high scrap prices but because of higher operations coupled with a tight situation in coke supplies, the groundwork is being laid for a possible shortage of pig iron this winter.

Semi-Finished Steel

Following heavy placement of orders last month, production and movement of semi-finished steel is at practical capacity. Orders at the new prices have been light so far this month, but this was expected by producers. Meanwhile, some non-integrated mills are having difficulty in obtaining sufficient semi-finished material. Scarcity of raw steel is slowing up finishing mill schedules in some integrated plants.

Bolts, Nuts and Rivets

Bookings by the automotive interests have picked up slightly over the past week, but have not assumed large proportions. A fair amount of tonnages are being ordered by the jobbing trade. Producers are pinning their hopes for a better volume of business on a resumption of railroad and railroad car builders' buying.

Bars

Bookings at fourth quarter prices have been light over the past week, but this condition had been expected in view of the heavy commitments made during the last week of September. Backlogs are better than six weeks, with finishing mills being scheduled at practical capacity. Meanwhile, consumption of hot-rolled bars is showing a steady increase. Orders on the books disclose a wide diversification. Considerable tonnages are going to manufacturing plants for repair and replacement of obsolete machinery. Demand for alloy bars has picked up over the past week owing to heavier automotive and farm implement specifications.

Cold-Finished Bars

New business continues light. Backlogs are now higher than at any time since 1929 and run in many cases to eight weeks and longer. It is a foregone conclusion that when heavier automobile releases are received considerable pressure will be exerted for deliveries. Sensing this condition, some consumers are now endeavoring to anticipate requirements over and above those already placed. No heavy volume of business at the new prices is expected, however, before the end of the month. Producers have added a new classification in the quantity extras and deductions set up. Previously, the deduction on 100,000 lb. and over

A Comparison of Prices

Market Prices at Date, and One Week, One Month, and One Year Previous; Advances Over Past Week in Heavy Type, Declines in Italics

Rails and Semi-finished Steel

Per Gross Ton:	Oct. 13, 1936	Oct. 6, 1936	Sept. 15, 1936	Oct. 15, 1935
Rails, heavy at mill	$36.37½	$36.37½	$36.37½	$36.37½
Light rails, Pittsburgh	35.00	35.00	35.00	35.00
Rerolling billets, Pittsburgh	32.00	32.00	30.00	27.00
Sheet bars, Pittsburgh	32.00	32.00	30.00	28.00
Slabs, Pittsburgh	32.00	32.00	30.00	27.00
Forging billets, Pittsburgh	39.00	39.00	37.00	35.00
Wire rods, Nos. 4 and 5, P'gh	40.00	40.00	38.00	38.00
	Cents	Cents	Cents	Cents
Skelp, grvd. steel, P'gh, lb.	1.80	1.80	1.80	1.70

Finished Steel

Per Lb.:	Cents	Cents	Cents	Cents
Bars, Pittsburgh	2.05	2.05	1.95	1.85
Bars, Chicago	2.10	2.10	2.00	1.90
Bars, Cleveland	2.10	2.10	2.00	1.90
Bars, New York	2.40	2.40	2.30	2.20
Plates, Pittsburgh	1.90	1.90	1.90	1.80
Plates, Chicago	1.95	1.95	1.95	1.85
Plates, New York	2.19	2.19	2.19	2.09
Structural shapes, Pittsburgh	1.90	1.90	1.90	1.80
Structural shapes, Chicago	1.95	1.95	1.95	1.85
Structural shapes, New York	2.16¼	2.16¼	2.16¼	2.06¼
Cold-finished bars, Pittsburgh	2.35	2.35	2.25	1.95
Hot-rolled strips, Pittsburgh	1.95	1.95	1.95	1.85
Cold-rolled strips, Pittsburgh	2.60	2.60	2.60	2.60
Hot-rolled annealed sheets, No. 24, Pittsburgh	2.60	2.60	2.50	2.40
Hot-rolled annealed sheets, No. 24, Gary	2.70	2.70	2.60	2.50
Sheets, galv., No. 24, P'gh	3.20	3.20	3.20	3.10
Sheets, galv., No. 24, Gary	3.30	3.30	3.30	3.20
Hot-rolled sheets, No. 10, Pittsburgh	1.95	1.95	1.95	1.85
Hot-rolled sheets, No. 10, Gary	2.05	2.05	2.05	1.95
Cold-rolled sheets, No. 20, Pittsburgh	3.05	3.05	3.05	2.95
Cold-rolled sheets, No. 20, Gary	3.15	3.15	3.15	3.05
Wire nails, Pittsburgh	2.05	2.05	1.90	2.40
Wire nails, Chicago dist. mill	2.10	2.10	1.95	2.45
Plain wire, Pittsburgh	2.50	2.50	2.40	2.30
Plain wire, Chicago dist. mill	2.55	2.55	2.45	2.35
Barbed wire, galv., P'gh	2.55	2.55	2.40	2.80
Barbed wire, galv., Chicago dist. mill	2.60	2.60	2.45	2.85
Tin plate, 100-lb. box, P'gh	$5.25	$5.25	$5.25	$5.25

On export business there are frequent variations from the above prices. Also in domestic business, there is at times a range of prices on various products, as shown in our detailed price tables.

Pig Iron

Per Gross Ton:	Oct. 13, 1936	Oct. 6, 1936	Sept. 15, 1936	Oct. 15, 1935
No. 2 fdy., Philadelphia	$21.3132	$21.3132	$21.3132	$20.3132
No. 2, Valley furnace	19.50	19.50	19.50	18.50
No. 2, Southern Cin'ti	20.2007	20.2007	20.2007	19.2007
No. 2, Birmingham†	15.88	15.88	15.88	14.50
No. 2, foundry, Chicago*	19.50	19.50	19.50	18.50
Basic, del'd eastern Pa.	20.8132	20.8132	20.8132	19.8132
Basic, Valley furnace	19.00	19.00	19.00	18.00
Malleable, Chicago*	19.50	19.50	19.50	18.50
Malleable, Valley	19.50	19.50	19.50	18.50
L. S. charcoal, Chicago	25.7528	25.7528	25.7528	24.7528
Ferromanganese, seab'd carlots	75.00	75.00	75.00	85.00

†This quotation is subject to a deduction of 38c. a ton for phosphorus content of 0.70 per cent or higher.
*The switching charge for delivery to foundries in the Chicago district is 60c. per ton.

Scrap

Per Gross Ton:				
Heavy melting steel, P'gh	$18.00	$18.25	$17.75	$13.50
Heavy melting steel, Phila.	15.75	15.75	15.50	12.00
Heavy melting steel, Ch'go.	16.25	16.25	16.25	12.50
Carwheels, Chicago	16.50	16.50	16.00	12.75
Carwheels, Philadelphia	16.75	16.75	16.75	12.75
No. 1 cast, Pittsburgh	16.25	16.25	16.25	14.25
No. 1 cast, Philadelphia	16.75	16.75	16.75	11.75
No. 1 cast, Ch'go (net ton)	14.00	14.00	13.50	11.25
No. 1 RR. wrot., Phila.	15.75	15.75	15.75	12.25
No. 1 RR. wrot., Ch'go (net)	14.25	14.25	14.25	9.50

Coke, Connellsville

Per Net Ton at Oven:				
Furnace coke, prompt	$3.75	$3.75	$3.65	$3.60
Foundry coke, prompt	4.25	4.25	4.00	4.25

Metals

Per Lb. to Large Buyers:	Cents	Cents	Cents	Cents
Electrolytic copper, Conn.	9.75	9.75	9.75	9.00
Lake copper, New York	9.87½	9.87½	9.87½	9.37½
Tin (Straits), New York	44.62½	45.37½	45.00	53.00
Zinc, East St. Louis	4.85	4.85	4.85	4.85
Zinc, New York	5.22½	5.22½	5.22½	5.22½
Lead, St. Louis	4.45	4.45	4.45	4.35
Lead, New York	4.60	4.60	4.60	4.50
Antimony (Asiatic), N. Y.	12.50	12.50	12.50	15.75

The Iron Age Composite Prices

	Finished Steel	Pig Iron	Steel Scrap
Oct. 13, 1936	2.197c. a Lb.	$18.73 a Gross Ton	$16.67 a Gross Ton
One week ago	2.197c.	18.73	16.75
One month ago	2.159c.	18.73	16.50
One year ago	2.130c.	17.84	12.67

Based on steel bars, beams, tank plates, wire rails, black pipe, sheets and hot-rolled strips. These products represent 85 per cent of the United States output.

Based on average of basic iron at Valley furnace and foundry irons at Chicago, Philadelphia, Buffalo, Valley and Southern iron at Cincinnati.

Based on No. 1 heavy melting steel quotations at Pittsburgh, Philadelphia and Chicago.

	Finished Steel High	Finished Steel Low	Pig Iron High	Pig Iron Low	Steel Scrap High	Steel Scrap Low
1936	2.197c., Sept. 29	2.084c., Mar. 10	$18.84, Jan. 7	$18.73, Aug. 11	$16.75, Sept. 22	$12.67, June 9
1935	2.130c., Oct. 1	2.124c., Jan. 8	18.84, Nov. 5	17.83, May 14	13.42, Dec. 10	10.33, April 23
1934	2.199c., April 24	2.008c., Jan. 2	17.90, May 1	16.90, Jan. 27	13.00, Mar. 13	9.50, Sept. 25
1933	2.015c., Oct. 3	1.867c., April 18	16.90, Dec. 5	13.56, Jan. 3	12.25, Aug. 8	6.75, Jan. 3
1932	1.977c., Oct. 4	1.926c., Feb. 2	14.81, Jan. 5	13.56, Dec. 6	8.50, Jan. 12	6.43, July 5
1931	2.037c., Jan. 13	1.945c., Dec. 29	15.90, Jan. 6	14.79, Dec. 15	11.33, Jan. 6	8.50, Dec. 29
1930	2.273c., Jan. 7	2.018c., Dec. 9	18.21, Jan. 7	15.90, Dec. 16	15.00, Feb. 18	11.25, Dec. 9
1929	2.317c., April 2	2.273c., Oct. 29	18.71, May 14	18.21, Dec. 17	17.58, Jan. 29	14.08, Dec. 3
1928	2.286c., Dec. 11	2.217c., July 17	18.59, Nov. 27	17.04, July 24	16.50, Dec. 31	13.08, July 2
1927	2.402c., Jan. 4	2.212c., Nov. 1	19.71, Jan. 4	17.54, Nov. 1	15.25, Jan. 11	13.08, Nov. 22

was 12½c. a 100 lb. The new bracket now allows a 15c. deduction a 100 lb. for 300,000 lb. and over, while the 12½c. deduction applies to quantities of 100,000 to 299,999 lb. Extras for size on rounds, 9/16 in. and smaller, have been revised and reflect reductions running from 5c. to $1.70 a 100 lb.

Shapes and Plates

Consumers of heavy plates are specifying freely and present volume of business compares favorably with that received over the past month. American Bridge Co. has received a contract from Carnegie-Illinois Steel Corp. for the construction of 25 standard steel coal barges of the riveted and welded type, involving 3800 tons of plates and shapes. Specifications for heavy shapes have shown no change from recent activity.

Steel Sheet Piling

Jones & Laughlin Steel Corp. will furnish 477 tons of steel sheet piling for dam No. 4, Allegheny River at Braeburn, Pa. An award involving approximately 892 tons of piling for a sewage disposal plant at Buffalo went to Carnegie-Illinois Steel Corp. Bids will be received shortly on three projects for the All American Canal at Potholes, Cal., involving approximately 150 tons each.

Strip

Orders for both hot and cold-rolled strip continue to flow in freely and backlogs on cold-rolled strip have increased at some plants. Fair tonnages are being placed by motor car manufacturers, but initial production difficulties have prevented them from accurately estimating their future requirements. Producers expect a heavier flow of orders from this source within the next week or so. Orders from miscellaneous sources continue unabated.

Tin Plate

With some producers having already received packers' can specifications for 1937 crops, more of this business is expected within the next month or so. Meanwhile backlogs are sufficient to maintain operations at 90 per cent despite the fact that aggregate demand has been falling off. The drop off in general line can specifications has been slight. A few last-minute clean-up orders for 1936 crops, for immediate delivery, have been received in the past week.

Tubular Products

Gulf Oil Corp., Pittsburgh, has placed an order for approximately 290 miles of 10-in. line pipe. It will be used for loops in the company's oil line running from Jenks, Okla., to Dublin, Ind., and will require 30,000 tons of seamless steel pipe. Jones & Laughlin Steel Corp. will furnish 10,000 tons, while the remainder of the order will be made by National Tube Co. This is the largest single line pipe order placed in several months. Demand for tubular products continues to show strength. There has been further slight improvement in bookings of boiler tubes with railroads taking a fair share of the total.

Wire Products

Specifications at fourth quarter quotations are extremely light in view of the heavy tonnages placed before the close of last month. Consumption of merchant wire items in the agricultural regions is showing some increase. Since jobbers' stocks have been abnormally low, much of the material now on the books will go into consumption as soon as it is received. An increase in building activity is being reflected in a more active movement of wire nails.

Sheets

Aggregate specifications eased off during the past week. This is not unusual considering the extremely heavy tonnages booked during September. Production continues at a high rate with no change in backlogs. Consumption is well diversified with refrigerator, farm implement and drum manufacturers taking a considerable amount of material.

Coal and Coke

Coal production continues to increase. Domestic purchases are gaining daily and industrial plants are accumulating heavy stocks in anticipation of winter weather and possible labor disturbances. Present union wage contracts run out on April 1, 1937, and in view of the tieup of the United Mine Workers with the Lewis Committee on Industrial Organization, some observers look for a stormy period when deliberations on new contracts begin. Anticipatory buying and production this fall and winter will be heavy. Some steel mills which catered to the domestic coke trade in the past few years will be unable to supply much, if any, to those channels this year since they need for their own use all they can produce. Meanwhile inquiries for domestic size coke are pouring in from distant points with little chance of many of them being satisfied, unless more beehive ovens are put into operation. Practically all those operating now are tied up with contracts running from three to six months. At least two beehive furnace coke contracts, placed early this year, are due to run out within the next month or so, but it is almost certain they will be renewed. Meanwhile prices for beehive furnace coke are expected to go higher within the near future. With present quotations at $3.75 to $4.00 a ton, f.o.b. Connellsville, sales at the lower range are the exception rather than the rule.

Warehouse Business

A local steel warehouse has advanced black wire to 3.05c. a lb. and galvanized wire to 3.40c. a lb. for delivery in the Pittsburgh switching district. Common wire and cement coated nails have been reduced from 2.35c. to 2.30c. a lb., delivered in the local switching district.

. . . Steel output gains in southern Ohio.

o o o

. . . Sheet mills operating at full capacity.

CINCINNATI, Oct. 13. — The steady improvement in the finished steel market is reflected in a sharp upturn in ingot production in this area to approximately 92 per cent, a new peak for the year. Only two open hearths in this district will be idle this week. Sheet demand is holding to more than capacity proportions as consumers gradually reach their full ordering stride. Substantial portions of present business is for future use since sheet users seek the assurance of a steady supply of material. Delivery dates are now the important part of inquiries and the trade has virtually abandoned question as to prices. Mills in this area are running full tilt and some officials declare additional units could be operated profitably if available.

Pig iron orders for 400, 150 and 100 tons respectively of Southern iron were placed in the past week and furnace interests indicate these will, in all probability, be the forerunners of further heavy contracting this quarter. Foundry operations are at 75 per cent and prospects are for a further increase.

Foundry coke is more active under the stimulus of an improved melt.

. . . . CHICAGO . . . .

. . . Indications point to further rise in ingot production.

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. . . October volume of business surprising on top of heavy September buying.

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. . . Backlogs getting heavier and deliveries are further delayed.

CHICAGO, Oct. 13. — Ingot production remains firmly established at 76 per cent of capacity, with numerous signs pointing to a further climb. Both new buying and specifications for finished steel are close to the high of the year and inquiries and pressure for deliveries show that the trend is upward.

Volume buying at this time comes as somewhat of a surprise to producers, who had visualized the price advance as having driven in sufficient consumer tonnage for 60 days, if not the entire quarter. However, it now develops that many users did not look far enough ahead, while others caught in the mesh of deferred deliveries are pyramiding, where possible, in order to meet urgent needs. Backlogs are gaining weight and promises to ship are gradually being pushed back.

The business field is dotted with railroad purchases and more of this kind of business is to come.

The rising tide of industrial activity is resulting in a shortage of open top railroad equipment for loading at coal mines. This situation needs close attention on the part of steel shippers and users. A rush of releases at bar mills, brought about by automobile production, has pushed deliveries back to an average of four weeks, and the peak of demand has not yet been reached. Mill shipments of structural materials remain steady and high and plate mills are getting more business for bridges, railroad cars, tanks, not to mention a potential 3000 tons for an ice breaker for the State of Michigan.

Specialties are bringing forth the first signs of renewed activity in the scrap market.

Pig Iron

October shipments are climbing fast as automobile foundries reach a new stride. New sales are moving forward in good volume and all indications point to both sales and shipments for the fourth quarter being the best of the year. Charcoal iron price advances have not disturbed the market and the three furnaces now in blast are shipping the full make.

Rails

Although numerous guesses are being made as to what will be done with rail prices there are no positive statements being made by producers. Mills will need new business in about 30 days if present operations are to be maintained or expanded and sellers seem to be confident that the needed tonnages will be forthcoming. It is the opinion of some that attractive tonnages now in the making will be ordered without regard to price, the rails being badly needed. The light rail market has come to life and shipments are the best in several years. Accessory buying is confined to odd and small lots, but sellers are busy filling old orders taken before prices were advanced.

Wire Products

The mental hazard of higher prices has worn off to the point where all classes of the trade are freely entering the market and October promises to be one of the best, if not the top month of the year, as gaged by purchases and shipments. Jobbers who have been hanging back are now actively in the market. All lines of manufacturing are in volume production and automobile consumption of wire products is of peak proportions. Wire rope and electrical cables have staged a remarkable comeback and railroad business is better. Reinforcing mesh, a seasonal article, is in a slump because of the approach of freezing weather. Wire mill operations range between 70 and 75 per cent of capacity.

Strip

Mills are operating at capacity and cannot promise better than from eight to ten weeks deliveries on new business. Automobile plants are drawing out heavy tonnages and miscellaneous use is excellent in all general lines.

Plates

Specifications are in good volume from a wide variety of consumers. The Wabash has started to order materials for the 425 cars it will build in its own shops and steel is being taken for the 50 cars ordered by the Cotton Belt. The Rock Island may buy 350 cars and other railroad inquiries, none of large size, are dotting the business picture. Railroad shop activity is exceptional as gaged by the last four or five years. Steel has been ordered for tanks requiring 1600 tons.

Structural Material

Shipments from mills remain at a high level and no improvement in deliveries is noted. Among 73 jobs, each of 100 tons or less, there is a greater number of private awards, a condition welcomed by the steel industry. The Chicago & North Western has broken the ice by placing a 400-ton span. Other awards include 900 tons for a bridge in Wisconsin and 650 tons for an overhead crossing in Chicago.

Bars

Demand for this commodity is increasing rapidly as automobile and parts makers swing into full fall production schedules. Deliveries now average four weeks and there is no indication of improvement in sight. The use of tonnages by farm equipment manufacturers continues to gain and the industry now sees ahead of it a good two and one-half months by which time it will have closed a successful year. New prices are holding, and it is quite evident that deliveries of needed steel bars are more important to consumers than the price structure.

Sheets

Miscellaneous and some tonnage business is brisk at the new prices. This situation is explained in part

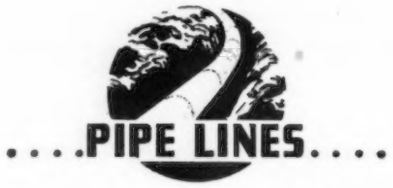
by the fact that before prices advanced many consumers were hesitant to look more than 30 to 60 days ahead. Now they find deliveries extended well toward the end of the quarter and their needs have outgrown earlier estimates. There is also evident some pyramiding as efforts to assure shipments in a market which is growing tighter as each day passes.

Cast Iron Pipe

All current business consists of small lots which are tied to WPA work. October shipments will be of good size, especially to the northern part of the country which will soon be in the grip of freezing weather. Sellers have been shaping stocks in efforts to keep them low but well balanced. There is no indication of variation from established price levels.

Reinforcing Bars

Inquiries are expanding and all signs point to an active fall and no immediate letdown from capacity shop operations. Fabricators are being forced, because of mill deliveries, to hold well-rounded stocks and to issue frequent mill specifications. Price structures to contractors are steady and jobbers do not anticipate advanced prices by mills at this time. The State of Illinois is releasing highway work, both bridges and slabs being involved. Two industrial contracts call for a total of over 700 tons. Pending apartment projects in Chicago do not promise early awards.



Gulf Oil Corp., Pittsburgh, has awarded 20,000 tons of steel pipe to National Tube Co. and 10,000 tons to Jones & Laughlin Steel Corp. to be used as loops in company's line from Jenks, Okla., to Dublin, Ind., about 290 miles.

Baltimore will ask bids early in November for proposed Loch Raven-Montebello water tunnel, with alternate figures on steel pipe and concrete pipe for sections A, B and C, with bituminous-lined 10-ft. steel pipe for section D. Entire project will cost about $5,000,000. Leon Small is city water engineer.

Panama Canal Bureau, 1435 K Street, N. W., Washington, plans 8 and 10-in. steel pipe lines for diesel oil transmission from oil-handling plant at Mount Hope to oil-loading piers Nos. 7 and 8 at Cristobal, Canal Zone. Cost about $78,000. A fund of $102,000 has been authorized also for pipe lines and oil-loading facilities at piers Nos. 15, 16 and 18, Balboa, Canal Zone.

E. L. Buckley, Robstown, Tex., and associates plan new 5½-in. welded steel pipe line from oil field at Driscoll, Tex., to Banquette, Tex., about 14 miles, where connection will be made with trunk pipe line to Corpus Christi, Tex., for crude oil transmission.

Stillwater, Okla., plans about eight miles of steel pipe for main water supply in connection with extensions and improvements in municipal water system. Entire project will cost close to $300,000.

Leflore County Gas Co., Poteau, Okla., plans 8-in. Lindewelded steel pipe line from Red Oak, Okla., to point about 10 miles from Poteau, about 25 miles, for natural gas transmission. Cost over $200,000 with booster stations and operating facilities.

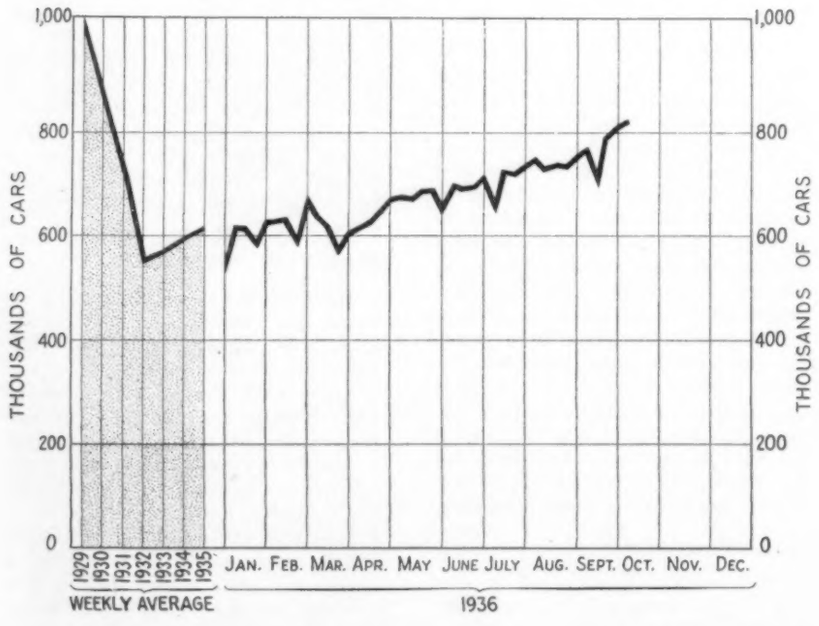
Standard Oil Co. of Louisiana, Shreveport, La., plans steel pipe line gathering system for crude oil service in Cotton Valley oid field area, Louisiana. Cost close to $100,000.

Benent Gas Co., Petersburg, Ind., plans welded steel pipe line to points south of Petersburg, for natural gas transmission from new gas field district in northern part of Patoka Township. Company is operated by Reynolds Corp., 5658 Delmar Boulevard, St. Louis.

District Quartermaster, CCC District, Fort Sheridan, Ill., asks bids until Oct. 19 for 7200 ft. of black steel pipe (Proposal 2602-20).

La Veta, Colo., will ask bids soon on 10 and 12-in. steel pipe, with alternates on concrete pipe, from intake on Cucharas River to municipal reservoir, for water trunk line. Cost about $30,000.

Des Moines, Wash., will purchase 20,460 ft. of 1½ to 6-in. steel pipe for extensions and improvements in water system. Financing has been arranged through Federal aid. Parker & Hill. Smith Tower Building, Seattle, are consulting engineers.



CARS OF REVENUE FREIGHT LOADED WEEKLY, 1936 TO DATE, COMPARED WITH AVERAGE LOADINGS IN FORMER YEARS. Total loadings for the week ended Oct. 3, 1936, amounted to 819,126 cars, an increase of 112,249 cars over the same week last year and 186,720 cars above the same week in 1934. The total was the highest since November, 1930. Loadings now are more than 275,000 cars greater than at the start of the year, and only about 195,000 below the 1929 weekly average.

Dearborn Chemical Co. is completing an extension to its main manufacturing plant in the central manufacturing district, Chicago. This is the third major addition in a dozen years and gives a 16 per cent increase in floor space, which will be utilized for the installation of new equipment needed to take care of the growing volume of business in several departments, and for a new modern machine shop. The Dearborn Laboratories were also remodeled, and new equipment installed.

Secretary of the Interior Harold I. Ickes has awarded contracts for two 15,000-hp. turbines and two governors to the Pelton Water Wheel Co., San Francisco, and two 12,000-kv. ampere generators to the Allis-Chalmers Mfg. Co., Milwaukee, for the Seminole power plant in the Casper-Alcova reclamation project in Wyoming. The turbine contract involved $100,546, the governor contract, $19,233 and the generator contract, $192,223.

. . . CLEVELAND . . .

. . . Ingot output declines slightly, but mill operations are heavy.

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. . . Some sheet producers virtually filled up for the quarter.

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. . . Business generally equal to that of first half of September.

CLEVELAND, Oct. 13.—Ingot output in the Cleveland-Lorain district declined two points this week to 78 per cent of capacity, the Lorain plant, which has been operating all its open hearths, having taken off one furnace for relining. A fourth blast furnace was started up in Lorain. In the valley district operations declined three points to 76 per cent of capacity.

Business in finished steel continues to come out in good volume, orders with some of the mills so far this month being slightly in excess of the business booked during the corresponding period in September. However, a moderate tapering off in new demand for bars and sheets was in evidence during the week. This apparently was due in the case of bars to the heavy volume of business placed before the fourth quarter price advance.

Some slowing down in orders for sheets was to be expected after the rush of consumers to get business on mill books in time to assure them desired deliveries during the remainder of the quarter. Some of the bar mills will have trouble in getting out this month all the tonnage they booked in September. All the sheet mills have heavy backlogs and some are practically filled up for the remainder of the year. With the automobile manufacturers getting under increased production schedules, sheet consumption is being materially increased by the motor car plants and parts makers, and, while there was a lull in new demand from that source the past week, buying is expected to be renewed shortly. Some sheet consumers are asking that material be shipped earlier than previously scheduled. Mills are being crowded for deliveries of semi-finished steel, the supply of which is not plentiful.

In the construction field activity is confined mostly to public work. However, two industrial projects that will require a large tonnage of structural shapes were announced during the week. One is a plant for the Industrial Rayon Corp. and the other a press shop for the Fisher Body plant in Cleveland.

There is little activity in the railroad field.

For a sewage disposal plant in Buffalo 890 tons of steel piling has been placed.

Pig Iron

New demand is very active, with business coming from all classes of consumers. Many foundries are buying iron to build up their inventories, which have been low for a long time. The high price and scarcity of foundry scrap evidently is a factor in encouraging them to do this and perhaps they are influenced to some extent by the talk of a price advance. Orders for good tonnages are now coming from the motor car foundries. Two steel plants in other districts that are not regular sellers of merchant iron are reported to have withdrawn from the market because they require all their iron for steel making. National Tube Co. blew in a furnace at Lorain Oct. 10, and is now operating four out of five stacks.

Bars, Plates and Shapes

New business in bars has declined, most consumers having bought rather heavily before the Oct. 1 price advance and are now taking shipments against these orders as fast as the mills can get the steel out. However, some business is being placed at the new price. Demand from forge shops has increased as these are stepping up operations on automobile parts. Alloy bars are quite active. Except for small lots, activity in the construction field is limited to public projects. A sewage treatment building in Cleveland, requiring 280 tons, has been awarded to the Fort Pitt Bridge Works Co. The Ohio Highway Department has new inquiries out for bridges and a garage taking 930 tons. Plates are in good demand.

Sheets

Incoming business from the automotive industry and from manufacturers in other fields has experienced a slight decline following the heavy volume of specifications that the mills received during the previous few weeks, when fear that they might not secure the deliveries they wanted caused many consumers to place orders for definite rolling schedules up into November. Some mills are about filled up for the remainder of the year on all grades. Others cannot promise shipments within five to six weeks. Barrel manufacturers have come into the market for sizable lots for manufacturing alcohol drums, the seasonal demand for which is now at hand. Considerable business continues to come from refrigerator manufacturers and business continues good from makers of stoves and other household equipment.

Strip Steel

Demand continues good, but not as heavy as during the previous few weeks. One mill in this territory is about filled up with both hot and cold-rolled strip for the remainder of the quarter and another has no more cold strip to sell for this year's delivery. Shipments by other producers range from two to three weeks for hot strip and three to four for cold material. There is considerable pressure for deliveries, some of which is from consumers, who, while not in urgent need of steei, want to have enough strip in stock so that they will not be in danger of running short later.

Bolts and Nuts

The volume of business so far this month has exceeded that of September, which was the best month in five years with the lead-

ing local manufacturer. Heavy releases are now coming from motor car manufacturers. Large bolts are rather quiet, but makers expect an early improvement for these from railroads.

. . . Two blast furnaces resume activity.

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. . . U. S. Steel officials to visit Southern plant.

BIRMINGHAM, Oct. 13. — Two more Ensley blast furnaces of the Tennessee Coal, Iron & Railroad Co. are scheduled to resume production this week, preparatory to the reopening of the Ensley rail mill about Nov. 1. These will increase the district's active total to 12 and again equal the high point of the year. For the past three months 10 furnaces have been in blast, the Tennessee company operating four, Woodward Iron Co. two, Sloss-Sheffield Steel & Iron Co. two and Republic Steel Corp. two. With the additions of this week, the Tennessee company will have four active stacks at Ensley and two at Fairfield, or one-half of the district's total.

An increase in steel production is also scheduled for later in the month. Two open hearths will be added at the Ensley works of the Tennessee company for rail mill operations. Three are now in production at Ensley. The district's total at present is 14, made up of seven at Fairfield, three at Ensley and four at Gadsden. The increase will bring steel production to the highest point since April, 1931, with the exception of July and August, 1933.

The Ensley rail mill will run continuously for several months. Three rail orders have already been announced. Louisville & Nashville has bought 27,000 tons; Seaboard Air Line, 10,000 tons, and Central of Georgia, 5000 tons. Other orders are pending.

Pig iron buying, while not at the rate of several weeks ago, when foundries rushed in to cover fourth quarter requirements, is satisfactory. Contract tonnage is larger than at the start of any other quarter this year. Shipments this month are also ahead of the same period in September.

New steel tonnage continues plentiful, with demand active in all lines. In the last few weeks bookings of building sheets and wire products were particularly heavy. Some mills are running behind on their shipments; in one case, nearly two weeks. Steel producers now have no worries as to the fourth quarter and expect that the first quarter of next year will also be good.

Considerable interest has been aroused in the visit this week of high officials of the United States Steel Corp. and the special stockholders' meeting of the Gulf States Steel Co. on Oct. 19. It is expected that each will bring announcements of important new developments.

On Thursday and Friday of this week Myron C. Taylor, chairman of the board; William A. Irvin, president, and other officials of United States Steel will be in Birmingham. It is expected that the party will include E. R. Stettinius, Jr., chairman of the finance committee; W. J. Filbert, former chairman of the committee; Robert Gregg, vice-president in charge of sales; C. S. Belsterling, vice-president in charge of traffic; A. W. Vogt, comptroller, and several others. A luncheon will be given for the party on Thursday by the Tennessee Coal, Iron & Railroad Co. It is believed that a new mill will be announced at that time.

It has also been reported that the Gulf States Steel Co. is contemplating new developments at a cost of around $2,000,000, and it is thought that these will be announced after the meeting on Oct. 19.

Shook & Fletcher Supply Co. has begun shipping brown ore from its new plant at Russellville.

Last week Republic Steel Corp. began work on a new air shaft at its Sayreton coal mine.

The fact finding commission that is studying the ore mine wage plan of the Tennessee Coal, Iron & Railroad Co., which resulted in a strike during the summer, will hold its second meeting on Thursday of this week. This committee is composed of members appointed by the Governor, the company and the union.

August was the second largest month in the history of the Bantam Ball Bearing Co., South Bend, Ind., according to a statement by A. Harold Frauenthal, general manager. "Demands for our bearings in the steel and other heavy industries are taxing even our increased capacity," said Mr. Frauenthal, referring to a recent plant addition in South Bend, and, "from all indications this demand will increase during the next few months."

. . . Business improving in all lines.

o o o

. . . Scrap price lists revised upward.

TORONTO, Ont., Oct. 13.—New business continues to appear in good volume in the Canadian iron and steel markets, and recent inquiries indicate that future delivery buying will become more general within the next few weeks. Various materials are slated for higher price levels and this is having a stimulating effect on current sales. Additional orders are expected from the railroads, both for rails and rolling stock. Demand for diversified lines of iron and steel is running close to the peak level for the year.

Demand for pig iron has increased recently with sales for the past week passing 1000 tons. Local blast furnace representatives state that sales are more numerous than formerly and many melters are taking larger tonnages. Several melters have contracted for last quarter requirements and others are said to be considering placing forward delivery contracts. Pig iron production is showing improvement with four stacks in blast, and it is understood that one and possibly two additional stacks will blow in at an early date. Imports of iron are limited to small lots of special grades from the United States. Prices are firm and unchanged.

Trading in iron and steel scrap has shown sharp improvement. Local dealers state that consumers are placing orders at frequent intervals and tonnages involved are larger than those earlier in the year. Revised price lists have been issued showing higher levels for several lines, while a number of grades have been dropped from the list. In handing out revamped lists dealers state that they have eliminated the lines that are dormant or have disappeared from dealers' yards. Dealers now are offering $10.50 to $11 for No. 1 heavy melting steel and $9.50 to $10 for No. 2 heavy melting, against the former price of $7 a ton. Machinery cast is $11.50 to $12 a ton and a new item, dealers' cast, has been included at $10.50 to $11.

...Pig iron buying is steady.

o o o

...Manufacturing activity at a good pace.

BOSTON, Oct. 13.—Little, if any, change is noted in the status of the pig iron market. Foundries are still placing orders both for prompt and fourth quarter shipment. The weekly average holds around 2000 tons. The position of the average New England foundry is sounder than it has been at any time in the past five years, and sentiment is that business is more apt to increase than decline despite the fact it is an election year.

New England general manufacturing activity shows indications of attaining the highest level of the year in the last quarter, mainly because of momentum given to lines that have been stagnant for a long time. Automobile accessory plants are becoming quite active; refrigerator makers are going strong; machine tool builders are doing relatively better than those in other sections of the country; while hardware manufacturers have made rapid gains. Carlot shipments from the Everett, Mass., plant of the Warren Foundry & Pipe Corp. are in large volume, demand for 6-in. stock being especially heavy.

...Awards of 4300 tons —4010 tons in new projects.

AWARDS

New York, 359 tons, Treasury Department work, to W. Ames & Co.

Northport, N. Y., 700 tons, hospital, to Fireproof Products Co.

State of New Jersey, 170 tons, two bridges, to Igoe Brothers.

Rochester, N. Y., 300 tons, Bond Clothing Co. factory, to Bethlehem Steel Co.

Cleveland, 200 tons, elevator for Fairchild Milling Co., to Truscon Steel Co.

Milwaukee, 360 tons, Pittsburgh Plate Glass Co., to Concrete Engineering Co. and Joseph T. Ryerson & Son, Inc.

Milwaukee, 168 tons, storage house H. Joseph Schlitz Brewing Co., to W. H. Pipkorn Co., Milwaukee.

Chicago Heights, Ill., 250 tons, American Manganese Steel Co., to an unnamed bidder.

Los Angeles, 610 tons, Lincoln high school, to Concrete Engineering Co.

Los Angeles, 166 tons, Central Avenue bridge floor system, to Consolidated Steel Corp.

Los Angeles, 135 tons, Glenoaks Boulevard bridge floor system, to Consolidated Steel Corp.

Los Angeles, 135 tons, Jackson Street bridge floor system, to Consolidated Steel Corp.

Los Angeles, 100 tons, Washington Boulevard high school, to Blue Diamond Steel Corp.

Los Angeles, 100 tons, arts and science building at Lindberg junior high school, to an unnamed bidder.

Los Angeles, 101 tons, material for Treasury Department, to an unnamed bidder.

Fife, Wash., 117 tons, State overcrossing, to an unnamed bidder.

Denver, 175 tons, Parker Dam project, to Republic Steel Corp.

Denver, 140 tons, Salt River project, to Bethlehem Steel Co.

NEW REINFORCING BAR PROJECTS

Minard County, Ill., 200 tons, highway bridge.

Chicago, 400 tons, Randolph Street viaduct.

State of Illinois, tonnage being estimated, bridges; bids Oct. 16.

Evansville, Ind., 125 tons, housing project; Ring Construction Co., Minneapolis, low bidder on general contract.

Denver, 493 tons, railroad overpass; bids Oct. 20.

Los Angeles, 150 tons, bridges and highway work; bids Oct. 29.

Denver, 894 tons, four invitations for All-American Canal project; bids opened.

Denver, 142 tons, Burnt River project; bids opened.

San Francisco, 1600 tons, University Mound Reservoir Basin; bids advanced to Oct. 29.

Los Angeles, 6000 tons, post office and jail; bids advanced to Oct. 22.

Higher Carloadings Are Estimated

WASHINGTON, Oct. 13.—Iron and steel shipments during the fourth quarter of 1936 are estimated by Regional Shippers' Advisory Boards at 375,922 cars, an increase of 21.6 per cent over carloading in the last quarter of 1935. Coal and coke shipments are estimated at 2,016,861 carloadings, an increase of 10.3 per cent. Other estimates are: Coal and coke, 2,016,861 carloadings, an increase of 10.3 per cent; ore and concentrates, 296,217, an increase of 40.8 per cent; machinery and boilers, 29,890, an increase of 20.5 per cent; agricultural implements and vehicles, 13,297, an increase of 9.4 per cent and automobiles, trucks and parts, 185,024, an increase of 11.5 per cent.

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TEST THIS WELDING TORCH FREE FOR TWO WEEKS IN YOUR PLANT

. . . . NEW YORK. . . .

. . . Orders for those products that were advanced in price have fallen off.

o o o

. . . But business generally continues at a very good rate.

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. . . Export business expected to be good, owing to European delivery situation.

NEW YORK, Oct. 13.—The volume of steel business since Oct. 1 has not kept pace with the rate of buying during the last two weeks of September, but it is approximately equal to the tonnage that was placed during the corresponding period early last month. Orders for those products on which prices were advanced for the fourth quarter have fallen off to a considerable extent, but there is virtually no change in the volume of orders for other products that were not advanced.

The delivery situation shows no change for the better. Hot-rolled annealed sheets are quoted four to five weeks, with some mills not interested in any miscellaneous business for the entire quarter. Cold-rolled material is not promised in less than six to seven weeks, while galvanized sheets are not better than eight to nine weeks.

Currency devaluation by foreign countries may ultimately affect American steel export trade adversely, but for the near term an upward trend in our exports is expected owing to the delivery situation abroad. American steel companies have been able to obtain higher prices than quoted by European competitors because of being able to quote better deliveries. When the European mills are in a better competitive situation on deliveries the present advantage of American mills may disappear.

Pig Iron

Sellers are not booking much tonnage at present, but there is no lull in shipments, and consumption therefore is indicated to be active. It is generally agreed that the market has a great deal of strength in prospect, not only owing to the trend in consumption but because prices may be raised. Pig iron users have already attempted to buy for the first quarter, although normally they have to wait until December before covering. Undoubtedly a clarification of the wage situation now before the steel industry would do much to crystallize opinion as to what to do about prices for iron.

Reinforcing Steel

Leading the list of awards this week was 700 tons of bars for a hospital at Northport, Long Island, which went to Fireproof Products Co. W. Ames & Co. were awarded 359 tons by the Treasury Department, and Igoe Brothers received about 170 tons for two bridges in New Jersey. Price cutting is still prevalent in this district. Additional requirements for bars on the Sixth Avenue subway and various bridges and other road work in New Jersey and Long Island, which are expected to be announced over the next few weeks, furnish a brightness to the market which has not been evident for some time. It is possible, however, that the coming of colder weather will so hinder road construction work as to delay the placing of the bars involved until spring.

. . SAN FRANCISCO . .

. . . Structural and reinforcing steel more active.

o o o

. . . Skagit River project to cost $7,000,000.

SAN FRANCISCO, Oct. 12. — Both structural and reinforcing steel markets showed a distinct gain in activity last week, though most awards were small. Structural steel awards totaled 1850 tons, while reinforcing bar lettings were 2475 tons. Los Angeles, with several school and bridge projects, again led the reinforcing market.

Outstanding among pending projects is a half-mile railroad bverpass to be constructed near Denver which will involve 1199 tons of shapes and 493 tons of reinforcing bars. Bids were opened on 894 tons, in four invitations, of bars to be used in the All-American Canal project. In Los Angeles bids were advanced to Oct. 22 on the Federal building involving 20,000 tons of shapes and 6000 tons of bars. The total estimated cost of this combined post office and jail is $6,500,000.

Oakland, Calif., started its East Bay Municipal Utility District project by calling for bids on approximately 1200 tons of 4, 6, 8 and 16-in. cast iron pipe. Bids will be opened Oct. 21.

A $3,000,000 PWA grant has been made to Seattle, Wash., for the construction of power generating and transmission facilities. The project includes a reservoir and dam on the Skagit River. Bids are expected some time this fall on the job, which is expected to cost over $7,000,000.

Again labor difficulties are threatening the steel industry, as well as every other industry on the Pacific Coast, with the extended agreement between longshoremen and shipowners expiring Oct. 15. It is barely possible, according to authorities, that an agreement which will satisfy both parties will be reached before that time. Arbitration seems to offer the only likely solution.

... Pig iron sales holding at a high level.

o o o

... Stove foundries are operating at capacity.

ST. LOUIS, Oct. 13.—The Missouri Pacific Railway has purchased 2000 tons of 112-lb. rails from Carnegie-Illinois Steel Co.

October shipments and sales of pig iron are fully as heavy as they were thus far in September. Last month's sales were the largest for any month this year. Most of the large melters have covered on their requirements for the remainder of the year, unless there should be a further increase in buying of castings. The large stove foundries in the Belleville district continue operations at the peak rate six days a week, their volume being of record-breaking proportions. The agricultural implement business farther north in Illinois is showing marked improvement, and a good season is anticipated, the industry not being affected as adversely by the drought as had been believed. Producers of tractors are going strong on a three-shift basis. Foundries serving the washing machine industry are being operated to capacity.

A small spurt in the demand for structural shapes from fabricators was reported during the last week. Buying of items on which advances of $2 a ton became effective Oct. 1 has subsided.

Independent Subway System, owned by the City of New York, is planning to purchase between 110 and 250 new subway cars.

Boston & Maine has bought five Mountain type locomotives from Baldwin Locomotive Works costing $125,000 each, and five Pacific type locomotives from Lima Locomotive Co. at $100,000 each.

Chicago, Rock Island & Pacific is taking bids on six three to four-car streamlined trains and contemplates purchase of 350 all-steel automobile box cars.

Bethlehem Steel Co. is building 100 70-ton hopper cars in its own shops.

Kennecott Copper Co. is inquiring for 240 100-ton lightweight flat-bottom steel ore cars.

Yellow Truck & Coach Mfg. Co., Detroit, has received an order from the Greyhound Lines (Pennsylvania Railroad) for 505 highway coaches.

Gulf, Mobile & Northern is inquiring for 100 gondola cars and 150 box cars, with alternate bid on 400 box cars, all of 50-tons capacity.

Union Pacific is inquiring for 20 4-8-4 type locomotives.

Wheeling & Lake Erie is inquiring for 10 2-8-4 type locomotives.

Universal Atlas Cement Co., Chicago, has ordered one diesel-electric switch engine from American Locomotive Co.

Baltimore & Ohio has started reconditioning and repair of 100 freight locomotives in its shops at Mount Clare, and Cumberland, Md., Glenwood and DuBois, Pa.

Seaboard Air Line has ordered 10 passenger coaches from Pullman Car & Mfg. Co.

RAILS AND TRACK SUPPLIES

Missouri Pacific has placed 2000 tons of 112-lb. rails with Carnegie-Illinois Steel Corp.

Fall River, Mass., has awarded 170 tons of 8-in. to United States Pipe & Foundry Co.

Manchester, N. H., has awarded 100 tons of 6-in. to Warren Foundry & Pipe Corp.

Englishtown, N. J., plans pipe lines for water system and other waterworks installation. Fund of $100,000 is being arranged through Federal aid. Runyon & Carey, 31 Fulton Street, Newark, N. J., are consulting engineers.

Washington Suburban Sanitary Commission, Tower Building, Washington, asks bids until Oct. 23 for 35,500 ft. of 12, 14 and 16-in. for pipe lines for water system. Plans at office of chief engineer, Hyattsville, Md.

West Blocton, Ala., closes bids Oct. 27 for about three and one-half miles of 4-in. for water system and other waterworks installation. John M. Gilfillan, Lyric Building, Birmingham, is consulting engineer.

West Unity, Ohio, has approved bonds for $28,000 and will arrange additional fund through Federal aid to make gross appropriation of $68,000 for pipe lines for water system and other waterworks installation.

Breckenridge, Mich., plans pipe lines for water system; also other waterworks installation, including pumping machinery and accessories. Cost about $50,000. Financing is being arranged through Federal aid. Francis Engineering Co., Saginaw, Mich., is consulting engineer.

Jonesboro, Ill., is arranging financing in amount of $50,000 through Federal aid for pipe lines for water system and other waterworks installation. Marr, Green & Opper, 400 North Michigan Avenue, Chicago, are consulting engineers.

Haddam, Kan., plans pipe lines for water system and other waterworks installation. Fund of $47,300 has been secured through Federal aid. Paulette & Wilson, National Reserve Building, Topeka, Kan., are consulting engineers.

Jackson County Public Water District No. 3, recently chartered, care of I. Frank Rope, Fidelity Bank Building, Kansas City, Mo., attorney and representative, plans call for bids soon for pipe for water system and other waterworks equipment in part of Jackson County, Mo., near Dallas. Fund of $130,000 is being secured through Federal aid. C. M. Kerr, water department, Kansas City, Mo., is consulting engineer.

Willapa Valley Water District, Raymond, Wash., plans pipe lines for water system and other waterworks installation in Pacific County. Cost about $71,660 with other waterworks installation, including pumping station. Bond issue of $19,000 has been approved, remainder of fund to be secured through Federal and state aid.

Oakland, Cal., will open bids Oct. 21 on about 1200 tons of 4, 6, 8 and 16-in. pipe for an East Bay Municipal Utility District project.

La Mesa, Cal., will open bids Oct. 19 on 101 tons of 4 and 6-in. for the Lemon Grove and Spring Valley Irrigation District project.

Walnut Creek, Cal., has advanced bids to Oct. 15 on 547 tons of 4, 6, 8 and 10-in. pipe.

The Best Shear Blade You Can Buy Carries This Mark

MORE TONNAGE PER EDGE OF BLADE

AMERICAN SHEAR KNIFE CO.
HOMESTEAD, PENN.

...German boom continues, both in domestic and export markets.

o o o

...Industrials announce increased dividends.

o o o

...July export total highest since 1929.

HAMBURG, Germany (By Special Correspondence). — The boom continues in the domestic and export markets. All delivery dates have been extended again, and three months is about the best shipping date that can be obtained for regular plate specifications. Pig iron production in August was 1,361,936 tons with 111 furnaces in blast, an increase of four over July. The demand for bars and joists for export was very heavy and a record turnover was again reported for the first half of September, the export sales keeping pace proportionally with increased production. Export totals, excluding scrap, amounted to 336,000 tons in July, the highest since 1929. Of this total, wire rods is excepted, only about 3 per cent of total production being exported as compared with from 28 to 38 per cent of other products going to other countries. Finished wire products, however, are selling very well, almost all export markets buying heavily at present with delayed delivery dates being necessary.

The United States has placed rather important orders for medium thick plates and hoops. Armor plate is being purchased by Japan, Italy, Greece, Portugal, Holland and others, at about $500 per ton. Ship plate is now being offered for February, 1937, shipment, and no orders for alloy steels, bright steel, rust resisting steels, etc., can be booked for shipment before February and March, more than 50 per cent of all makers declining to book additional orders.

The machine industry reports a further rise in production, with unfilled orders on hand for the next 17 to 18 weeks. The machine tool industry, however, suffering from a shortage of skilled labor, reports at least 22 to 24 weeks are necessary to take care of orders at hand, with backlogs at some plants amounting to nearly one year. Nearly all works are operating at 100 per cent, and export figures are continuing their upward tendency. Russia, in spite of the political tension, is foremost among buyers of German machines. Purchases from Italy lately have been greatly reduced.

The Swedish steel industry is operating at 90 per cent of capacity, the Czechoslovakian at about 70 per cent, Hungarian at nearly 100 per cent, Austrian at 75 per cent, Polish at 60 per cent, and the Rumanian industry at 90 per cent. Present business and further outlook for steel demand is satisfactory in all these countries. Only Luxembourg and France have produced less steel this year than in 1935, all other countries' output being considerably more. In France, however, this slackening in production has been caused by strikes, price advances, and uncertainty about the economical policy of the government. Demand is strong and shipments have been delayed greatly.

German steel production amounted to 1,725,025 tons in August, compared with 1,721,556 tons in july and 1,317,440 tons in the same period last year.

The Swedish iron and steel industry has advanced export prices for the fourth consecutive time since 1934. The average Swedish pig iron export price is now 115 kroner as compared with 96 kroner two years ago f.o.b. Swedish ports. The steel price advance exceeds 20 per cent for some products. The demand continues at a very high scale.

According to latest statistics, industrial production in the second quarter of 1929 has already reached and exceeded the stand of 1929. Only a few industries are still behind, but the total is above 1929. The whole German industry in August was operating at 71.5 per cent of the total possible capacity, three shifts calculated. The average working time per workman (nearly 20,000,000 workmen and employees) in the German industry was 7.51 hr. per day.

The steel industry shows a further big gain. The industry operated in August at 90.7 per cent of capacity compared with 89.7 per cent in July. The machinery industry raised its production further to 87.2 per cent of capacity.

Committee Recognized By the Corporation

THE Carnegie-Illinois Steel Corp., through its manager of industrial relations, on Tuesday recognized a committee of 18 employees for collective bargaining purposes. This group will be called the General Council of Employees' Representatives. The Corporation also agreed to changes in the by-laws of the employees' representation plan which are designed to give the representatives more power. This action comes as a result of a two-day meeting between management and representatives from the various Pittsburgh and Youngstown plants. According to the chairman of the new General Council, representatives regard the recognition of the central committee as a preliminary step toward granting of a wage increase, since this group has now been recognized as an authorized bargaining agency. In view of the recognition of the central group, the representatives of the Corporation's Homestead works which had placed Oct. 15 as a deadline for a decision on a pay increase, have indicated that an extension to Oct. 20 will be made. This committee had previously stated that unless a wage increase was granted the subject would be forced into arbitration.

Heavy-Duty Inclinable Press in New Models

A NEW heavy duty, adjustable stroke inclinable press is announced by E. W. Bliss Co., Brooklyn, N. Y., as an addition to the Bliss-Consolidated line, built by the Consolidated Press Division at Hastings, Mich.

In the single geared press shown arrangement is for direct connected motor drive. Improved designs in jaw and fast rolling key clutches are offered to suit service requirements. Timken roller bearings and bronze-bushed main and crankpin bearings reduce friction. The stroke is adjustable for 2, 4 and 6 in., with a diespace of 19 in. for 2 in. stroke, 18 in. for the 4 in. stroke and 17 in. for the 6 in. stroke. An adjustable eccentric is locked rigidly in place by a patented rolling key device providing easy and convenient adjustment. Operation is at 40 strokes per min. when geared. Optional geared and non-geared operation may be had in special cases.

. . PHILADELPHIA . .

. . . Some mills booked on bars and sheets to end of year.

o o o

. . . Autobody stamping plants operating at high rate.

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. . . Ingot output remains steady at 55½ per cent of capacity.

PHILADELPHIA, Oct. 13.—Some mills are booked nearly to the end of the quarter on bars, sheets and plates, and backlogs on other items extend from one to seven weeks. With good business continuing and backlogs holding steady and, in some cases, lengthening, deliveries are still the great problem confronting both buyer and seller. In some instances, plates notably, new business has fallen off slightly, but it is thought that this lull is only temporary, and sellers expect orders to pick up after election. The general feeling for the remainder of the year is very optimistic.

The Heintz Mfg. Co. reports the best business and the largest payroll in the company's history, with the new Overland model, the International Harvester Co. panel body program, and stainless steel work on naval vessels accounting for much of its activity. The Edward G. Budd Mfg. Co., which is now occupied with Dodge, Plymouth, and Chrysler body panels, Chevrolet chassis frames, and Ford truck bodies, is fabricating about 600 tons of steel daily, and expects in a few weeks to increase this figure to about 1000 tons. Now in the Budd train shops are two Burlington "Zephyrs" and one Santa Fe streamlined train, which should keep the shops busy until December, when other work is expected to be available. Both of these companies have been specifying heavily lately and have bought in advance to some extent in order to avoid confusion arising from delivery delays.

Changes in the extras on cold finished bars and manufacturers' wire have made the two products more nearly equal in price, while a change in the classification for pool car loads in merchant wire products now places this type of shipment on the joint car load base price, and adds quantity differential rates of 5c. per 20,000 lb. or more, 10c. for 8000 lb. to 20,000 lb., and 15c. for shipments of less than 8000 lb.

Ingot output is unchanged this week at 55½ per cent of capacity.

Pig Iron

Local furnaces are operating at a good rate and are said to be able to dispose of most of their output and add somewhat to stocks also. One mill reports good sales of northern iron in this district, although no large amounts were purchased. Sellers are still undecided as to whether a price increase should be announced before the end of the year or should be withheld until 1937.

Sheets and Plates

Demand for sheets continues strong, with backlogs extending from two and three weeks for some grades to 10 weeks for others. Galvanized and enameling sheets are in good demand with deliveries requiring from three to four weeks in most cases. Strip may be obtained from 10 days to three weeks. The sales office here of a Pittsburgh mill reports it is booked almost to the end of the quarter on plates, while district mills can deliver plates in a week's time. Plate sellers attribute the slack in business to the temporary cessation of railroad buying, but expect an end to the slump soon. The Pennsylvania Railroad is asking for bids today on one to three car floats, each requiring 370 tons of steel plates. The American Bridge Co. received an order for 25 coal barges from Carnegie-Illinois Steel Corp. which will require the fabrication at Ambridge, Pa., of 3800 tons of plates and shapes.

Wire Products

Wire nail prices have not yet been tested, but sellers believe the 2.05c. base will be respected. Buying is light at the moment, most consumers being covered until Nov. 1.

Shapes and Bars

Among the structural awards reported this week was 165 tons for a boiler house addition at the RCA Victor Mfg. Co. plant in Camden, which was awarded to Belmont Iron Works. In addition to over 2000 tons of shapes which will be bid on Oct. 16, 1300 tons will come up Oct. 23 for bids at Harrisburg. Shape mills are busy and deliveries require about three weeks in most cases. Reinforcing bars are quiet this week, although the increasing number of grade crossing eliminations and other highway projects should bring out some tonnage soon. One sales office reports its mill is booked to the middle of December on hot rolled bars with no let up in demand in sight.

Imports

The following iron and steel imports were received here last week: 10 tons of ferrochrome and 40 tons of ferromanganese from Japan; 249 tons of pig iron from British India; 8 tons of steel billets, 27 tons of cold drawn wire, 142 tons of steel tubes, 24 tons of steel forgings and 29 tons of steel bars from Sweden; 31 tons of diamond floor plates and 47 tons of structural shapes from Belgium.

Research projects fostered by the Engineering Foundation, New York, will be illustrated in an exhibit to be held at the William Penn Hotel, Pittsburgh, in connection with the fall meeting of the American Society of Civil Engineers, Oct. 14 and 15. The work of the iron alloys and welding research committees of the foundation will be shown. The exhibit will be in charge of Frank T. Sisco, editor of the iron alloys committee, who will also participate in the discussions of the papers presented before the symposium on structural application of steel and light alloys.

. . . Mills continue to run at high rate.

° ° °

. . . Several building jobs awarded.

BUFFALO, Oct. 13.—Business continues fairly good, and mills continue to operate at a high rate of capacity. Bethlehem's Lackawanna plant has 22 out of 24 open hearths active; Republic seven out of nine and Wickwire-Spencer Steel Co., 2 out of four.

At Niagara Falls, the Carborundum Co. has taken bids on the general contract for a 275-ton structural alteration job. The Worthington Pump & Machinery Corp., Buffalo, has awarded the contract for a 200-ton structural addition. The Linde Air Products Co. research laboratory and office building job has been awarded. This will require 1200 tons of fabricated structural steel. It is reported that the 2500 tons of structural steel for the Tifft Street viaduct has been awarded to a Buffalo company, but the contract is not yet official.

Reinforcing bar and rail steel fields are quiet, with the exception of the awarding of the contract for 300 tons of bars for the Bond Clothing Co. factory in Rochester, N. Y., to a Buffalo maker.

Shipments of pig iron against the heavy orders booked two and three weeks ago, are in considerable volume. Operations of blast furnaces are the same, but it is expected that a Wickwire-Spencer Steel Co. stack will be blown in some time this week or next.

A new container recently put into use by **Carboloy Co., Inc.**, Detroit, for shipping Carboloy tools, dies and wheel dressers, is specially designed to withstand wear and assure rapid identification in the stock room or tool crib. Constructed of heavy, compressed fibre board and reinforced with strong metal edges, these boxes will resist the weight of a 200-lb. man and are sufficiently tough to stand up under rough handling. A specially processed coating resists grease and smudge so that the boxes may be readily identified at all times. The boxes are used in some cases as a permanent, protective container for Carboloy tools.

Lubrication Products Co., 5103 Detroit Avenue, Cleveland, has consolidated the manufacture and sale of its "Stapax" lubricating pad at Cleveland, having moved its factory from Burgettstown, Pa., to the above-mentioned address, where larger space has been taken.

. . . Pig iron shortage causes sales curtailment.

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. . . Orders for finished steel offered in large amounts.

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. . . French home market active with franc devaluation.

LONDON, England, Oct. 13. (*By Cable*).—The pig iron shortage is unrelieved. Specifications are increasing and consumers are still anxious to place new business, but makers, having sold most of what they will produce between now and the end of March, are declining further orders.

Users of finished and semi-finished steel complain of inadequate and delayed deliveries. Some producers are temporarily closing their books in an effort to reduce arrearages. Billet makers are fully sold until the end of the year, but arrangements have been made for large supplementary imports from the Continent.

Finished steel makers have been offered orders in embarrassing amounts and are accelerating output and expansion plans.

Export inquiry for tinplate is again broadening as the market settles down to new currency conditions. Home demand is fairly active.

The Continental iron and steel market is fairly active with good demand for semi-finished steel and plates. South America is buying bars and United States sections. The French home market is quite busy, as further price advances are expected because of devaluation of the franc and the imminent introduction of the 40-hr. week. Exporters expect to benefit temporarily from devaluation, but fear rising production costs will soon again render exports unprofitable.

British prices are unchanged, as are Continental gold prices.

Modern Tool Works, a division of Consolidated Machine Tool Corp., Rochester, N. Y., announces opening of a new Cleveland office in the Union Building, 1836 Euclid Avenue. John B. Moreton is in charge of sales and service in Cleveland territory.

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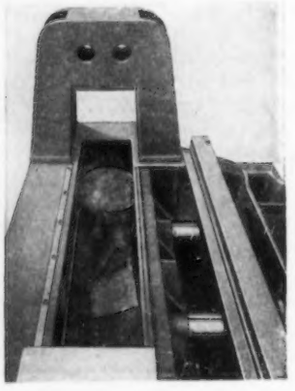

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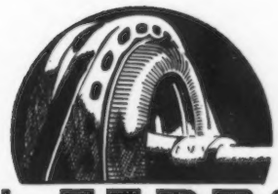

. . .NON-FERROUS. . .

. . . Zinc stocks declined 9500 tons in September.

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. . . Copper and lead unchanged; tin inquiry strengthens

NEW YORK, Oct. 13—Domestic copper continues to sell in moderate to quiet volume, with daily bookings during the past week equal to about 1000 tons average. Demand from foreign users, however, has strengthened and recent prices received on this business ranged between 9.75c. to 9.77½c. a lb., usual European base ports. With the metal markets closed yesterday, no business was done. Copper circles, however, feel that the situation is decidedly strong in undertone, and interest is focused upon the September statistics which will be released this week. There is no change in the domestic quotation for copper at 9.75c. a lb., Connecticut Valley.

The Week's Prices. Cents Per Pound for Early Delivery

	Oct. 7	Oct. 8	Oct. 9	Oct. 10	Oct. 12	Oct. 13
Electrolytic copper, Conn.*	9.75	9.75	9.75	9.75	9.75	9.75
Lake copper, N. Y.	9.87½	9.87½	9.87½	9.87½	9.87½	9.87½
Straits tin, Spot, New York	45.00	45.12½	45.25	....	....	44.62½
Zinc, East St. Louis	4.85	4.85	4.85	4.85	4.85	4.85
Zinc, New York†	5.22½	5.22½	5.22½	5.22½	5.22½	5.22½
Lead, St. Louis	4.45	4.45	4.45	4.45	4.45	4.45
Lead, New York	4.60	4.60	4.60	4.60	4.60	4.60

* Delivered Connecticut Valley; price ¼c. lower delivered in New York.
† Includes emergency freight charge.

Aluminum, virgin 99 per cent plus 19.00c.-21.00c. a lb. delivered.
Aluminum, No. 12 remelt No. 2 standard, in carloads, 16.50c. a lb. delivered.
Nickel, electrolytic, 35c. to 36c. a lb. base refinery, in lots of 2 tons or more.
Antimony, Asiatic, 12.50c. a lb., New York.
Quicksilver, $88.00 to $92.00 per flask of 76 lb.
Brass ingots, commercial 85-5-5-5, 9.75c. a lb., delivered; in Middle West ¼c. a lb. is added on orders for less than 40,000 lb.

From New York Warehouse

Delivered Prices, Base per Lb.

Tin, Straits pig	46.00c. to 47.00c.
Tin, bar	48.00c. to 49.00c.
Copper, Lake	10.75c. to 11.75c.
Copper, electrolytic	10.75c. to 11.75c.
Copper, castings	10.50c. to 11.50c.
*Copper sheets, hot-rolled	17.50c.
*High brass sheets	15.62½c.
*Seamless brass tubes	17.87½c.
*Seamless copper tubes	18.00c.
*Brass rods	13.62½c.
Zinc, slabs	5.75c. to 6.75c.
Zinc, sheets (No. 9), casks, 1200 lb. and over	10.25c.
Lead, American pig	5.10c. to 6.10c.
Lead, bar	6.10c. to 7.10c.
Lead, Sheets, cut	8.25c.
Antimony, Asiatic	13.00c. to 14.00c.
Alum., virgin, 99 per cent plus	23.30c.
Alum., No. 1 for remelting, 98 to 99 per cent	18.50c. to 20.00c.
Solder, ½ and ½	28.50c. to 29.50c.
Babbitt metal, commercial grades	25.00c. to 60.00c.

* These prices, which are also for delivery from Chicago and Cleveland warehouses, are quoted with 33⅓ per cent allowed off for extras, except copper tubes and brass rods, on which allowance is 40 per cent.

From Cleveland Warehouse

Delivered Prices Per Lb.

Tin, Straits pig	49.37½c.
Tin, Bar	51.37½c.
Copper, Lake	10.75c. to 11.00c.
Copper, electrolytic	10.75c. to 11.00c.
Copper, castings	10.50c. to 10.75c.
Zinc, slabs	6.50c. to 6.75c.
Lead, American pig	5.20c. to 6.50c.
Lead, bar	8.50c.
Antimony, Asiatic	15.00c.
Babbitt metal, medium grade	19.00c.
Babbitt metal, high grade	53.37½c.
Solder, ½ and ½	26.75c.

Old Metals, Per Lb., New York

Buying prices are paid by dealers for miscellaneous lots from smaller accumulators, and selling prices are those charged to consumers after the metal has been prepared for their uses. (All prices are nominal.)

	Dealers' Buying Prices	Dealers' Selling Prices
Copper, hvy. crucible	7.50c.	8.25c.
Copper, hvy. and wire	7.37½c.	7.87½c.
Copper, light and bottoms	6.37½c.	6.87½c.
Brass, heavy	4.25c.	4.87½c.
Brass, light	3.50c.	4.25c.
Hvy. machine composition	6.25c.	6.75c.
No. 1 yel. brass turnings	5.25c.	5.75c.
No. 1 red brass or compos. turnings	5.87½c.	6.37½c.
Lead, heavy	3.62½c.	4.00c.
Sheet aluminum	13.25c.	14.75c.
Zinc	2.50c.	2.87½c.
Cast aluminum	12.12½c.	13.25c.

Zinc

Stocks of all grades of zinc declined 9564 tons during September to 76,630 tons at the month's end. Shipments rose over August by 5762 tons to a total of 51,847 tons, and production decreased 1331 tons to 42,283 tons. In prime Western grade there was a drop in the stocks of 3568 tons, leaving 54,198 tons in reserve at Sept. 30. Despite their excellence, the statistics were without effect on the market, as far as can be determined. Demand continued the week on a quiet basis, the price moved along unchanged at 4.85c., East St. Louis, and only shipments made a good account of themselves.

Tin

The market remained inactive throughout last week, and buyer absence was prolonged by suspension of trading on Columbus Day. While they netted tin dealers practically no business, prices nevertheless averaged above 45c. a lb. all during this period; in fact, at no point did the price fall beneath 45c. until today's break in the London market. This has lowered the New York spot Straits quotation to 44.62¼c., and at this level demand from consumers is again a feature. No explanation has been advanced as to what caused the London market to weaken. Today's standard prices in that market are £197 10s. cash and £196 three-months. The Eastern price is reported at £200 15s.

Lead

There is no change as to the state of inquiry in this market since last reported. Continued demand for prompt shipment, but with the bulk of sales for November, features each day's business, and volume is considered satisfactory to good by all leading sellers. The largest producer entered the week with an appreciable carryover of inquiry from last week, and has not yet been able to satisfy its customers. Inquiry remains diversified. The price holds firmly to 4.45c. a lb., St. Louis basis, being unchanged since the last week in February.

Ingot Brass and Bronze

The Non-Ferrous Ingot Metal Institute reports the average prices received by its members during the 28 days ended Oct. 2 on commercial 80-10-10 and commercial 85-5-5-5 brass ingots were 11.046c. and 9.531c. a lb. respectively. Preceding prices were fractionally higher at 11.064c. and 9.537c.

IRON AND STEEL SCRAP

. . . Nominal markdown at Pittsburgh forces composite down 8c. to $16.67.

o o o

. . . Buying is light in all areas.

o o o

. . . Sentiment is still favorable in major selling centers.

LACK of consumer buying and generally better flow of scrap supplies at Pittsburgh have been reflected in a nominal downward revision of the No. 1 heavy melting steel price there. As a consequence, THE IRON AGE composite price is 8c. lower at $16.87 a gross ton. Although this revised figure is higher than the level of a month ago, some significance may be attached to the fact that the current drop is the first downward change in the composite since early June.

All major consuming districts report little or no new buying. At the moment sellers are primarily engaged in filling old orders, and, for the most part, they are securing better deliveries than was the case a fortnight ago. Preliminary reports indicate that the No. 1 steel on the October Pennsylvania Railroad list was bid in at about $18.50 a ton, delivered Pittsburgh.

Pittsburgh

The market shows little activity with no large purchases being made either by brokers or consumers. Within the past week a local mill bought a few hundred tons of No. 1 steel at $18. Brokers are finding it a little easier to obtain steel at prices ranging from $17.50 to $17.75. Owing to these factors and more because of the absence of sales, No. 1 steel is off 25c., being quotable at $17.75 to $18.25. Consumption of scrap in the district remains high, and, since the market still shows a strong undertone, there is a good possibility that higher prices would be paid in cases where large tonnages would be involved.

Chicago

The undertone of the market is slightly easier but has not yet been translated into lower consumer prices. Brokers are trying to draw some profits out of past deals by offering less to owners of scrap. However, margins remain slim as evidenced by heavy melting steel which commands $16.25 a ton in large lots. Railroads still demand and get better than $16.50, although offerings have been light in recent days. The specialty market is giving the first signs of added strength and more activity on the part of consumers.

Cleveland

A Youngstown district consumer has placed a moderate tonnage of No. 1 steel at a reported price of $17.75, which is 25c. a ton higher than its previous purchase price. This grade offered by the New York Central and Erie railroads last week was sold to Youngstown brokers at $17.25. These brokers also purchased some No. 1 at $15.25, Cleveland. Machine shop turnings and shoveling turnings have advanced 50c. a ton. Other grades are unchanged but very firm. Present prices are bringing out only a moderate supply of scrap.

Philadelphia

No mill has openly bought for the past ten days or two weeks, and buyers and sellers alike are marking time at present. The market remains quite firm and scrap is fairly plentiful. Some specialty grades were advanced this week as a reflection of higher prices paid by brokers on the Pennsylvania list. It is humored that the 11,000 tons of heavy melting steel on this same list was sold at around $18.50, delivered Pittsburgh.

Buffalo

Specialties are in demand and several sales are noted at around $19. Marked strength continues in all commodities although selling is not extensive. A sale of No. 2 steel is reported at $14.50, 2000 tons being involved. Shipment by Lake still is a big factor in the local situation and will continue so for the next 30 days. It is reliably reported that one Buffalo blast furnace interest has purchased 10,000 to 20,000 tons of borings and turnings within the past 30 days from upper Lake producers.

Boston

Pittsburgh Steel Co. is taking some skeleton for which brokers are paying $9.75 to $10 a ton on cars, which is about 50c. under the price ruling a fortnight ago. Pittsburgh district mills, following a long period of inactivity, are buying mixed borings and turnings and brokers are paying around $5.75 on cars to fill these orders. Brokers supplying the American Steel & Wire Co., Worcester, Mass., with Nos. 1 and 2 steel have again entered the market, but at a 50c. a ton reduction in price. They are now paying $12.90 and $11.90 for No. 1 and No. 2 respectively for shipment along the seaboard and even less for shipment from interior points. Weirton interests are holding up deliveries of steel turnings and are out of the market for skeleton. New England foundries continue to buy machinery cast at former prices, and there is a smattering of buying for export at unchanged prices.

New York

A number of mills are not ordering, but enough business is stirring to sustain the market, and quotations therefore are unchanged. Dealers and brokers foresee no shift in the situation for some weeks ahead, although they claim that a snow-fall might tighten supplies and force prices again higher. Consumers have attempted to lower current quotations by restricting orders, but not all mills have been able to hold off because of high operating rates. Local brokers were awarded only minor tonnages from the Pennsylvania Railroad's October list. On steel carwheels, couplers and springs one New York broker submitted a bid 50c. higher than he offered for similar items in September. The tonnage awarded him was slight.

St. Louis

A limited amount of heavy melting steel was bought by a mill in this district during the last week at current price levels. Dealers are reluctant to make any large commitments because they feel that sources of supply are drying up. There is still said to be a heavy short interest among dealers. The Missouri Pacific Railway has offered 75 carloads of scrap, including 20 carloads of rails and 25 carloads of No. 2 steel.

Cincinnati

Reported purchases at good prices in other areas have served to strengthen the undertone of the local scrap market. Dealers insist upon more attractive bids on the strength of a less abundant supply of old materials. Offers, the past week were adjusted, but otherwise published schedules are unaltered. Small mill ordering supplemented by sporadic purchases of foundry scrap constituted the market activity of the past week.

Iron and Steel Scrap Prices

PITTSBURGH

Per gross ton delivered to consumer:

No. 1 hvy. mltng. steel.	$17.75 to $18.25
No. 2 hvy. mltng. steel.	16.00 to 16.50
No. 2 RR. wrought	17.75 to 18.25
Scrap rails	18.00 to 18.50
Rails, 3 ft. and under	20.00 to 20.50
Comp. sheet steel	17.75 to 18.25
Hand bundled sheets	16.75 to 17.25
Hvy. steel axle turn.	16.25 to 16.75
Machine shop turn.	12.50 to 13.00
Short, shov. turn.	12.50 to 13.00
Mixed bor. & turn.	11.50 to 12.00
Cast iron borings	12.50 to 13.00
Cast iron carwheels	17.00 to 17.50
Hvy. breakable cast	14.50 to 15.00
No. 1 cast	16.00 to 16.50
RR. knuckles & cplrs.	20.50 to 21.00
Rail coil & leaf springs	20.50 to 21.00
Rolled steel wheels	20.50 to 21.00
Low phos. billet crops.	21.00 to 21.50
Low phos. sh. bar.	20.50 to 21.00
Low phos. punchings.	20.00 to 20.50
Low phos. plate scrap.	20.00 to 20.50
Steel car axles	19.50 to 20.00

CLEVELAND

Per gross ton delivered to consumer:

No. 1 hvy. mltng. steel.	$15.00 to $15.50
No. 2 hvy. mltng. steel.	14.00 to 14.50
Comp. sheet steel	14.50 to 15.00
Light bund. stampings	11.00 to 11.50
Drop forge flashings	14.00 to 14.50
Machine shop turn.	10.25 to 10.75
Short shov. turn.	11.00 to 11.50
No. 1 busheling	14.00 to 14.50
Steel axle turnings	11.00 to 11.50
Low phos. billet crops	19.00 to 19.50
Cast iron borings	10.50 to 11.00
Mixed bor. & turn.	10.50 to 11.00
No. 2 busheling	10.50 to 11.00
No. 1 cast	16.75 to 17.25
Railroad grate bars	9.00 to 9.50
Stove plate	9.00 to 9.50
Rails under 3 ft.	19.00 to 19.50
Rails for rolling	16.50 to 17.00
Railroad malleable	17.75 to 18.00
Cast iron carwheels	.... 15.50

PHILADELPHIA

Per gross ton delivered to consumer:

No. 1 hvy. mltng. steel.	$15.50 to $16.00
No. 2 hvy. mltng. steel.	14.00 to 14.50
Hydraulic bund., new	15.00 to 15.50
Hydraulic bund., old	12.50 to 13.00
Steel rails for rolling	17.00 to 17.50
Cast iron carwheels	16.50 to 17.00
Hvy. breakable cast	15.50 to 16.00
No. 1 cast	16.50 to 17.00
Stove plate (steel wks.)	12.50 to 13.00
Railroad malleable	.... 16.50
Machine shop turn.	9.50 to 10.00
No. 1 blast furnace	8.50 to 9.00
Cast borings	8.00 to 8.50
Heavy axle turnings	12.50 to 13.00
No. 1 low phos. hvy.	20.00 to 20.50
Couplers & knuckles	19.50 to 20.00
Rolled steel wheels	19.50 to 20.00
Steel axles	20.50 to 21.00
Shafting	20.50 to 21.00
No. 1 RR. wrought	16.00 to 16.50
Spec. iron & steel pipe	13.50 to 14.00
Bundled sheets	14.00 to 14.50
No. 1 forge fire	14.50 to 15.00
Cast borings (chem.)	10.50 to 13.00

CHICAGO

Delivered to Chicago district consumers:

	Per Gross Ton
Hvy. mltng. steel.	$16.00 to $16.50
Auto. hvy. mltng. steel.	14.00 to 14.50
Shoveling steel	16.00 to 16.50
Hydraul. comp. sheets.	15.00 to 15.50
Drop forge flashings	13.50 to 14.00
No. 1 busheling	14.75 to 15.25
Rolled carwheels	18.00 to 18.50
Railroad tires, cut	18.00 to 18.50
Railroad leaf springs	17.50 to 18.00
Axle turnings	15.00 to 15.50
Steel coup. & knuckles	18.00 to 18.50
Coil springs	19.00 to 19.50
Axle turn. (elec.)	16.00 to 16.50
Low phos. punchings	18.75 to 19.25
Low phos. plates, 12 in. and under	18.75 to 19.25
Cast iron borings	9.00 to 9.50
Short shov. turnings	10.00 to 10.50
Machine shop turn.	8.50 to 9.00
Rerolling rails	17.00 to 17.50
Steel rails under 3 ft.	17.00 to 17.50
Steel rails under 2 ft.	18.50 to 19.00
Angle bars, steel	18.00 to 18.50
Cast iron carwheels	16.50 to 17.00
Railroad malleable	18.50 to 19.00
Agric. malleable	.... 15.00
	Per Net Ton
Iron car axles	$18.50 to $19.00
Steel car axles	17.75 to 18.25
No. 1 RR. wrought	14.25 to 14.75
No. 2 RR. wrought	$14.25 to $14.75
No. 2 busheling, old	6.00 to 6.50
Locomotive tires	13.00 to 13.50
Pipes and flues	8.50 to 9.00
No. 1 machinery cast	14.00 to 14.50
Clean auto. cast	13.00 to 13.50
No. 1 railroad cast	13.50 to 14.00
No. 1 agric. cast	11.00 to 11.50
Stove plate	8.75 to 9.25
Grate bars	9.50 to 10.00
Brake shoes	10.50 to 11.00

BUFFALO

Per gross ton, f.o.b. consumers' plants:

No. 1 hvy. mltng. steel.	$16.00 to $16.50
No. 2 hvy. mltng. steel.	14.50 to 15.00
Scrap rails	16.00 to 16.50
New hy. b'ndled sheets	14.50 to 15.00
Old hydraul. bundles	13.00 to 13.50
Drop forge flashings	14.50 to 15.00
No. 1 busheling	14.25 to 15.00
Hvy. axle turnings	10.50 to 11.00
Machine shop turn.	8.50 to 9.00
Knuckles & couplers	18.50 to 19.00
Coil & leaf springs	18.50 to 19.00
Rolled steel wheels	18.50 to 19.00
Low phos. billet crops.	18.50 to 19.00
Short shov. turnings	9.75 to 10.25
Mixed Bor. & turn.	9.75 to 10.25
Cast iron borings	9.75 to 10.25
No. 2 busheling	11.00 to 11.50
Steel car axles	17.00 to 17.50
Iron axles	12.00 to 12.50
No. 1 machinery cast	15.00 to 15.50
No. 1 cupola cast	14.50 to 15.00
Stove plate	12.50 to 13.00
Steel rails under 3 ft.	17.50 to 18.00
Cast iron carwheels	15.50 to 16.00
Railroad malleable	17.00 to 18.00
Chemical borings	10.50 to 11.00

BIRMINGHAM

Per gross ton delivered to consumer:

Hvy. melting steel	.... $11.50
Scrap steel rails	$12.00 to 12.50
Short shov. turnings	.... 8.00
Stove plate	.... 8.00
Steel axles	13.50 to 14.00
Iron axles	13.50 to 14.00
No. 1 RR. wrought	8.50 to 9.00
Rails for rolling	13.50 to 14.00
No. 1 cast	.... 12.50
Tramcar wheels	.... 12.00

ST. LOUIS

Dealers' buying prices per gross ton delivered to consumer:

Selected hvy. steel	$14.50 to $15.00
No. 1 hvy. melting	14.25 to 14.75
No. 2 hvy. melting	12.50 to 13.00
No. 1 locomotive tires	13.50 to 14.00
Misc. stand.-sec. rails	15.00 to 15.50
Railroad springs	16.00 to 16.50
Bundled sheets	9.50 to 10.00
No. 2 RR. wrought	14.50 to 15.00
No. 1 busheling	8.50 to 9.00
Cast bor. & turn.	5.50 to 6.00
Rails for rolling	15.75 to 16.25
Machine shop turn.	4.00 to 4.50
Heavy turnings	10.50 to 11.00
Steel car axles	16.00 to 16.50
Iron car axles	17.00 to 17.50
No. 1 RR. wrought	12.50 to 13.00
Steel rails under 3 ft.	16.00 to 16.50
Steel angle bars	15.50 to 16.00
Cast iron carwheels	12.75 to 13.25
No. 1 machinery cast.	12.50 to 13.00
Railroad malleable	15.00 to 15.50
No. 1 railroad cast	12.50 to 13.00
Stove plate	7.50 to 8.00
Agricul. malleable	12.50 to 13.00
Grate bars	9.00 to 9.50
Brake shoes	11.25 to 11.75

CINCINNATI

Dealers' buying prices per gross ton:

No. 1 hvy. mltng. steel.	$14.00 to $14.50
No. 2 hvy. mltng. steel.	11.50 to 12.00
Scrap rails for mltng.	14.00 to 14.50
Loose sheet clippings	8.50 to 9.00
Bundled sheets	10.50 to 11.00
Cast iron borings	6.50 to 7.00
Machine shop turn.	7.50 to 8.00
No. 1 busheling	11.00 to 11.50
No. 2 busheling	6.50 to 7.00
Rails for rolling	15.00 to 15.50
No. 1 locomotive tires	12.50 to 13.00
Short rails	17.00 to 17.50
Cast iron carwheels	13.50 to 14.00
No. 1 machinery cast	14.00 to 14.50
No. 1 railroad cast	13.50 to 14.00
Burnt cast	9.50 to 10.00
Stove plate	9.50 to 10.00
Agricult. malleable	13.00 to 13.50
Railroad malleable	15.00 to 15.50

DETROIT

Dealers' buying prices per gross ton:

No. 1 hvy. mltng. steel.	$13.75 to $14.25
No. 2 hvy. mltng. steel.	12.75 to 13.25
Borings and turnings	9.00 to 9.50
Long turnings	$9.00 to $9.50
Short shov. turnings	10.25 to 10.75
No. 1 machinery cast	14.50 to 15.00
Automotive cast	14.50 to 15.00
Hydraul. comp. sheets.	14.50 to 15.00
Stove plate	8.50 to 9.00
New factory bushel	13.25 to 13.75
Old No. 2 busheling	8.50 to 9.00
Sheet clippings	10.25 to 10.75
Flashings	12.75 to 13.25
Low phos. plate scrap.	14.00 to 14.50

CANADA

Dealers' buying prices per gross ton:

	Toronto	Montreal
Hvy. melting steel	$10.75	$10.25
Rails, scrap	8.50	8.00
Machine shop turn.	4.25	4.25
Boiler plate	7.00	6.00
Hvy. axle turnings	4.50	4.00
Cast borings	4.75	4.25
Steel borings	4.00	4.00
Wrought pipe	4.00	4.00
Steel axles	8.50	9.00
Axles, wrought iron	9.00	9.50
No. 1 machinery cast	11.75	10.75
Stove plate	7.00	6.75
Standard carwheels	11.00	10.50
Malleable	7.00	7.00
Shoveling steel	6.50	6.00
Bushelings	6.00	5.50
Compressed sheets	6.50	6.00

YOUNGSTOWN

Per gross ton delivered to consumer:

No. 1 hvy. mltng. steel.	$17.50 to $17.50
Hydraulic bundles	16.50 to 17.00
Machine shop turn.	12.00 to 12.50

NEW YORK

Dealers' buying prices per gross ton:

No. 1 hvy. mltng. steel.	$11.75 to $12.25
No. 2 hvy. mltng. steel.	10.75 to 11.25
Hvy. breakable cast.	11.50 to 12.00
No. 1 machinery cast.	12.00 to 12.50
No. 2 cast	10.50 to 11.00
Stove plate	.... 10.00
Steel car axles	16.00 to 17.00
Shafting	15.00 to 16.00
No. 1 RR. wrought	12.00 to 12.50
No. 1 wrought long	11.00 to 11.50
Spec. iron & steel pipe	10.50 to 11.00
Forge fire	8.00 to 8.50
Rails for rolling	11.50 to 12.00
Short shov. turnings	5.75 to 6.25
Machine shop turn.	6.25 to 6.50
Cast borings	6.25 to 6.50
No. 1 blast furnace	5.00 to 5.50
Cast borings (chem.)	10.00 to 11.00
Unprepar. yard scrap.	6.50 to 7.00

Per gross ton, delivered local foundries:

No. 1 machn. cast	$14.00 to $14.50
No. 1 hvy. cast cupola.	11.50 to 12.00
No. 2 cast	10.50 to 11.00

Add 25c. to 50c. to above quotations to secure North Jersey prices.

BOSTON

Dealers' buying prices per gross ton:

No. 1 hvy. mltng. steel.	$11.40 to $11.90
Scrap rails	11.90 to 12.15
No. 2 steel	10.40 to 10.90
Breakable cast	10.00 to 10.25
Machine shop turn.	6.50 to 6.65
Bund. skeleton long	9.75 to 10.00
Shafting	15.25 to 15.75
Cast bor. chemical	5.00 to 7.00

Per gross ton delivered consumers' yards:

Textile cast	$12.00 to $13.50
No. 1 machine cast	12.00 to 13.50
Stove plate	9.50 to 10.00

EXPORT

Brokers' buying prices per gross ton:

New York, delivered alongside barges	
No. 1 hvy. mltng. steel.	$11.50 to $12.00
No. 2 hvy. mltng. steel.	10.50 to 11.00
No. 2 cast	.... 10.00
Stove plate	.... 10.00
Rails (scrap)	11.50 to 12.00
Boston, on cars at Army Base or Mystic Wharf	
No. 1 hvy. mltng. steel.	$12.00 to $12.50
No. 2 hvy. mltng. steel.	11.00 to 11.50
Rails (scrap)	12.50 to 12.75
Stove plate	7.75 to 8.00
Machine shop turn.	6.00 to 6.25
New Orleans, on cars at Stuyvesant Dock	
No. 1 hvy. mltng. steel.	$12.60 to $12.75
No. 2 hvy. mltng. steel.	11.60 to 11.75
Los Angeles, on cars or trucks at local piers	
No. 1 hvy. mltng. steel.	$10.50 to $11.00
Compressed bundles	8.50 to 9.00

PRICES ON FINISHED AND SEMI-FINISHED IRON AND STEEL

SEMI-FINISHED STEEL

Billets, Blooms and Slabs

F.o.b. Pittsburgh, Chicago, Gary, Cleveland, Youngstown, Buffalo, Birmingham. Prices at Duluth are $2 a ton higher, and delivered Detroit $3 higher.

	Per Gross Ton
Rerolling	$32.00
Forging quality	39.00

Sheet Bars

F.o.b. Pittsburgh, Chicago, Cleveland, Youngstown, Buffalo, Canton, Sparrows Point, Md.

	Per Gross Ton
Open-hearth or Bessemer	$32.00

Skelp

F.o.b. Pittsburgh, Chicago, Youngstown, Buffalo, Coatesville, Pa., Sparrows Point, Md.

	Per Lb.
Grooved, universal and sheared	1.80c.

Wire Rods

(No. 5 to 15/32 in.)

	Per Gross Ton
F.o.b. Pittsburgh or Cleveland	$40.00
F.o.b. Chicago, Youngstown or Anderson, Ind.	41.00
F.o.b. Worcester, Mass.	42.00
F.o.b. Birmingham	43.00
F.o.b. San Francisco	49.00
F.o.b. Galveston	46.00

BARS, PLATES, SHAPES

Iron and Steel Bars

Soft Steel

	Base per Lb.
F.o.b. Pittsburgh	2.05c.
F.o.b. Chicago or Gary	2.10c.
F.o.b. Duluth	2.20c.
Del'd Detroit	2.20c.
F.o.b. Cleveland	2.10c.
F.o.b. Buffalo	2.15c.
Del'd Philadelphia	2.36c.
Del'd New York	2.40c.
F.o.b. Birmingham	2.20c.
F.o.b. cars dock Gulf ports	2.45c.
F.o.b. cars Pacific ports	2.60c.

Rail Steel

(For merchant trade)

F.o.b. Pittsburgh	1.90c.
F.o.b. Cleveland, Chicago, Gary or Moline, Ill.	1.95c.
F.o.b. Buffalo	2.00c.
F.o.b. Birmingham	2.05c.
F.o.b. cars dock Gulf ports	2.30c.
F.o.b. cars dock Pacific ports	2.45c.

Billet Steel Reinforcing

(Straight lengths as quoted by distributors)

F.o.b. Pittsburgh	2.05c.
F.o.b. Buffalo, Cleveland, Youngstown, Chicago, Gary or Birmingham	2.10c.
Del'd Detroit	2.20c.
F.o.b. cars dock Gulf ports	2.45c.
F.o.b. cars dock Pacific ports	2.45c.

Rail Steel Reinforcing

(Straight lengths as quoted by distributors)

F.o.b. Pittsburgh	1.90c.
F.o.b. Buffalo, Cleveland, Youngstown, Chicago, Gary or Birmingham	1.95c.
F.o.b. cars dock Gulf ports	2.30c.
F.o.b. cars dock Pacific ports	2.30c.

Iron

F.o.b. Chicago	1.80c.
F.o.b. Pittsburgh (refined)	2.10c.
Delivered New York	2.05c.
Delivered Philadelphia	2.10c.

Cold Finished Bars and Shafting*

	Base per Lb.
F.o.b. Pittsburgh	2.35c.
F.o.b. Cleveland, Chicago and Gary	2.40c.
F.o.b. Buffalo	2.45c.
Del'd Detroit	2.50c.
Del'd eastern Michigan	2.55.c

*In quantities of 10,000 to 19,999 lb.

Plates

	Base per Lb.
F.o.b. Pittsburgh	1.90c.
F.o.b. Chicago or Gary	1.95c.
Del'd Cleveland	2.095c.
F.o.b. Coatesville or Spar. Pt.	2.00c.
Del'd Philadelphia	2.09c.
Del'd New York	2.19c.
F.o.b. Birmingham	2.05c.
F.o.b. cars dock Gulf ports	2.30c.
F.o.b. cars dock Pacific ports	2.45c.
Wrought iron plates, f.o.b. Pittsburgh	3.20c.

Floor Plates

F.o.b. Pittsburgh	3.45c.
F.o.b. Chicago	3.50c.
F.o.b. Coatesville	3.55c.
F.o.b. cars dock Gulf ports	3.85c.
F.o.b. cars dock Pacific ports	4.00c.

Structural Shapes

	Base per Lb.
F.o.b. Pittsburgh	1.90c.
F.o.b. Chicago	1.95c.
Del'd Cleveland	2.095c.
F.o.b. Buffalo or Bethlehem	2.00c.
Del'd Philadelphia	2.115c.
Del'd New York	2.1625c.
F.o.b. Birmingham (standard)	2.05c.
F.o.b. cars dock Gulf ports	2.30c.
F.o.b. cars dock Pacific ports	2.45c.

Steel Sheet Piling

	Base per Lb.
F.o.b. Pittsburgh	2.25c.
F.o.b. Chicago or Buffalo	2.35c.
F.o.b. cars dock Gulf or Pacific Coast ports	2.70c.

RAILS AND TRACK SUPPLIES

F.o.b. Mill

Standard rails, heavier than 60 lb per gross ton	$36.37½
Angle bars, per 100 lb.	2.55

F.o.b. Code Basing Points

Light rails (from billets) per gross ton	$35.00
Light rails (from rail steel) per gross ton	34.00

	Base per 100 Lb.
Spikes	2.75c.
Tie plates, steel	2.00c.
Tie plates, Pacific Coast ports	2.10c.
Track bolts, to steam railroads	3.75c.
Track bolts, to jobbers, all sizes (per 100 counts) 70 per cent off list	

Basing points on light rails are Pittsburgh, Chicago and Birmingham; on spikes and tie plates, Pittsburgh, Chicago, Buffalo, Portsmouth, Ohio, Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., Birmingham and Pacific Coast ports; on tie plates alone, Steelton, Pa.; on spikes alone, Cleveland, Youngstown, Lebanon, Pa., Columbia, Pa., Richmond, Va.

SHEETS, STRIP, TIN PLATE, TERNE PLATE

Sheets

Hot Rolled

	Base per Lb.
No. 10, f.o.b. Pittsburgh	1.95c.
No. 10, f.o.b. Gary	2.05c.
No. 10, del'd Detroit	2.15c.
No. 10, del'd Philadelphia	2.26c.
No. 10, f.o.b. Birmingham	2.10c.
No. 10, f.o.b. cars dock Pacific ports	2.50c.

Hot-Rolled Annealed

No. 24, f.o.b. Pittsburgh	2.60c.
No. 24, f.o.b. Gary	2.70c.
No. 24, del'd Detroit	2.80c.
No. 24, del'd Philadelphia	2.91c.
No. 24, f.o.b. Birmingham	2.75c.
No. 24, f.o.b. cars dock Pacific ports	3.25c.
No. 24, wrought iron, Pittsburgh	4.30c.

Heavy Cold-Rolled

No. 10 gage, f.o.b. Pittsburgh	2.60c.
No. 10 gage, f.o.b. Gary	2.70c.
No 10 gage, f.o.b. Detroit	2.80c.
No. 10 gage, del'd Philadelphia	2.91c.
No. 10 gage, f.o.b. Birmingham	2.75c.
No. 10 gage, f.o.b. cars dock Pacific ports	3.20c.

Light Cold-Rolled

No. 20 gage, f.o.b. Pittsburgh	3.05c.
No. 20 gage, f.o.b. Gary	3.15c.
No. 20 gage, del'd Detroit	3.25c.
No. 20 gage, del'd Philadelphia	3.36c.
No. 20 gage, f.o.b. Birmingham	3.20c.
No. 20 f.o.b. cars dock Pacific ports	3.60c.

Galvanized Sheets

No. 24 gage, f.o.b. Pittsburgh	3.20c.
No. 24, f.o.b. Gary	3.30c.
No. 24, del'd Philadelphia	3.51c.
No. 24, f.o.b. Birmingham	3.35c.
No. 24, f.o.b. cars dock Pacific ports	3.80c.
No. 24, wrought iron, Pittsburgh	4.95c.

Electrical Sheets

(F.o.b. Pittsburgh)

	Base per Lb.
Field grade	3.00c.
Armature	3.35c.
Electrical	3.85c.
Special Motor	4.90c.
Special Dynamo	5.60c.
Transformer	6.10c.
Transformer Special	7.10c.
Transformer Extra Special	7.60c.

Silicon Strip in coils—Sheet price plus silicon sheet extra width extras, plus 25c. per 100 lb. for coils.

Long Ternes

No. 24, unassorted 8-lb. coating f.o.b. Pittsburgh	3.50c.
F.o.b. Gary	3.60c.
F.o.b. cars dock Pacific ports	4.20c.

Vitreous Enameling Stock

No. 20, f.o.b. Pittsburgh	3.05c.
No. 20, f.o.b. Gary	3.15c.
No. 20, f.o.b. Birmingham	3.65c.
No. 20, f.o.b. cars dock Pacific ports	3.65c.

Tin Mill Black Plate

No. 28, f.o.b. Pittsburgh	2.75c
No. 28, Gary	2.85c
No. 28, cars dock Pacific ports	3.35c.

Tin Plate

	Base per Box
Standard cokes, f.o.b. Pittsburgh district mill	$5.25
Standard cokes, f.o.b. Gary	5.35

Terne Plate

(F.o.b. Pittsburgh)

(Per Package, 20 x 28 in.)

8-lb. coating I.C.	$10.00
15-lb. coating I.C.	12.00
20-lb. coating I.C.	13.00
25-lb. coating I.C.	14.00
30-lb. coating I.C.	15.25
40-lb. coating I.C.	17.50

Hot-Rolled Hoops, Bands, Strips and Flats under ¼ In.

	Base per Lb.
All widths up to 24 in., P'gh	1.95c.
All widths up to 24 in., Chicago	2.05c.
All widths up to 24 in., del'd Detroit	2.15c.
All widths up to 24 in., Birmingham	2.10c.
Cooperage stock, Pittsburgh	2.05c.
Cooperage stock, Chicago	2.15c.

Cold-Rolled Strips*

	Base per Lb.
F.o.b. Pittsburgh	2.60c.
F.o.b. Cleveland	2.60c.
Del'd Chicago	2.895c.
F.o.b. Worcester	2.80c.

* Carbon 0.25 and less.

Cold-Rolled Spring Steel

	Pittsburgh and Cleveland	Worcester
Carbon 0.25-0.50%	2.60c.	2.80c.
Carbon .51- .75	3.70c.	3.90c.
Carbon .76-1.00	5.45c.	5.65c.
Carbon Over 1.00	7.50c.	7.70c.

Fender Stock

No. 14, Pittsburgh or Cleveland	2.90c.
No. 14, Worcester	3.30c.
No. 20, Pittsburgh or Cleveland	3.30c.
No. 20, Worcester	3.70c.

WIRE PRODUCTS

(Carload lots, f.o.b. Pittsburgh and Cleveland.)

To Manufacturing Trade

	Per Lb.
Bright wire	2.50c.
Spring wire	3.05c.

Chicago prices on products sold to the manufacturing trade are $1 a ton above Pittsburgh or Cleveland. Worcester and Duluth prices are $2 a ton above, Birmingham $3 above, and Pacific Coast prices $9 a ton above Pittsburgh or Cleveland.

To the Trade

	Base per Keg
Standard wire nails	$2.05
Smooth coated nails	2.05

	Base per 100 Lb.
Annealed fence wire	$2.80
Galvanized fence wire	3.15
Polished staples	2.75
Galvanized staples	3.00
Barbed wire, galvanized	2.55
Twisted barbless wire	2.55
Woven wire fence, base column	60
Single loop bale ties, base column	52

Chicago and Anderson, Ind., mill prices are $1 a ton over Pittsburgh base (on all products except woven wire fence, for which the Chicago price is $2 above Pittsburgh); Duluth, Minn., mill prices are $2 a ton over Pittsburgh except for woven wire fence, which is $3 over Pittsburgh and Birmingham mill prices are $3 a ton over Pittsburgh.

On wire nails, barbed wire and staples, prices at Houston, Galveston and Corpus Christi, Tex., New Orleans, Lake Charles, La., and Mobile, Ala., are $6 a ton over Pittsburgh.

On nails, staples and barbed wire, prices of $6 a ton above Pittsburgh are also quoted at Beaumont and Orange, Tex.

STEEL AND WROUGHT IRON PIPE AND TUBING

Welded Pipe

Base Discounts, f.o.b. Pittsburgh District and Lorain, Ohio, Mills

F.o.b. Pittsburgh only on wrought iron pipe.

Butt Weld

Steel In.	Black	Galv.	*Wrought Iron* In.	Black	Galv.
⅛	.57	37	⅛	+91½	+138
¼ to ⅜	.60	44½	¼ & ⅜	+1½	+21½
½	.64½	55	½	.31½	15
¾	.67½	59	¾	.36½	20½
1 to 3	.69½	61½	1 & 1¼	.39½	25½
			1½	.43½	28
			2	.41½	26

Lap Weld

2	.62	53½	2	.37 22½
2½ to 3	.65	56½	2½ to 3½	38 25
3½ to 6	.67	58½	4 to 8	.40 28½
7 & 8	.66	56½	9 to 12	.38 24½
9 & 10	.65½	56		
11 & 12	.64½	55		

Butt Weld, extra strong, plain ends

⅛	.55½	42½	⅛	+13 +45½
¼ to ⅜	.57½	46½	¼ & ⅜	+2½ +34½
½	.62½	54½	½	.32½ 17½
¾	.66½	58½	¾	.37½ 22½
1 to 3	.68	61	1 to 2	.43½ 29

Lap Weld, extra strong, plain ends

2	.60	52½	2	.40 26
2½ to 3	.64	56½	2½ to 4.45	½ 33
3½ to 6	.67½	60	4½ to 6.45	33½
7 & 8	.66½	57	7 & 8	.46 33
9 & 10	.65½	56	9 to 12.41	½ 30
11 & 12	.64½	55		

On butt-weld and lap-weld steel pipe jobbers are granted a discount of 5%. On less-than-carload shipments prices are determined by adding 25 and 30% and the carload freight rate to the base card.

Note—Chicago district mills have a base two points less than the above discounts. Chicago delivered base is 2½ points less. Freight is figured from Pittsburgh, Lorain, Ohio, and Chicago district mills, the billing being from the point producing the lowest price to destination.

Boiler Tubes

Seamless Steel Commercial Boiler Tubes and Locomotive Tubes

(Net base prices per 100 ft. f.o.b. Pittsburgh in carload lots)

		Cold Drawn	Hot Rolled
1 in. o.d.	13 B.W.G.	$ 8.60	$ 7.82
1¼ in. o.d.	13 B.W.G.	10.19	9.26
1½ in. o.d.	13 B.W.G.	11.26	10.23
1¾ in. o.d.	13 B.W.G.	12.81	11.64
2 in. o.d.	13 B.W.G.	14.35	13.04
2¼ in. o.d.	13 B.W.G.	16.00	14.54
2¼ in. o.d.	12 B.W.G.	17.61	16.01
2½ in. o.d.	12 B.W.G.	19.29	17.54
2¾ in. o.d.	12 B.W.G.	20.45	18.59
3 in. o.d.	12 B.W.G.	$21.45	$19.50
3½ in. o.d.	10 B.W.G.	41.08	37.35
3½ in. o.d.	11 B.W.G.	27.09	24.62
4 in. o.d.	10 B.W.G.	33.60	30.54
4½ in. o.d.	10 B.W.G.	41.08	37.35
5 in. o.d.	9 B.W.G.	51.56	46.87
6 in. o.d.	7 B.W.G.	79.15	71.90

Extra for less-carload quantities:

25,000 lb. or ft. to 39,999 lb. or ft.	5	%
12,000 lb. or ft. to 24,999 lb. or ft.	12½	%
6,000 lb. or ft. to 11,999 lb. or ft.	25	%
2,000 lb. or ft. to 5,999 lb. or ft.	35	%
Under 2,000 lb. or ft.	50	%

CAST IRON WATER PIPE

	Per Net Ton
*6-in. and larger, del'd Chicago,	$48.40
6-in. and larger, del'd New York	45.20
*6-in. and larger, Birmingham	40.00
6-in. and larger, f.o.b. dock, San Francisco or Los Angeles	48.00
F.o.b. dock, Seattle	40.50
F.o.b. dock, Seattle	51.50

Class "A" and gas pipe, $3 extra.
4-in. pipe is $3 a ton above 6-in.

* Prices for lots of less than 200 tons. For 200 tons and over, 6-in. and larger is $39. Birmingham, and $47.40, delivered Chicago and 4-in. pipe, $42, Birmingham, and $50.40 a ton, delivered Chicago.

BOLTS, NUTS, RIVETS, SET SCREWS

Bolts and Nuts

(F.o.b. Pittsburgh, Cleveland, Birmingham or Chicago)

	Per Cent Off List
Machine and carriage bolts:	
½ in. x 6 in. and smaller	70 and 10
Larger than ½ in.	70 and 5
Lag bolts	70 and 5
Plow bolts, Nos. 1, 2, 3, and 7 heads	70 and 5
Hot-pressed nuts, blank or tapped, square	70 and 5
Hot-pressed nuts, blank or tapped, hexagon	70 and 5
C.p.c. and t. square or hex. nuts, blank or tapped	70 and 5
Semi-finished hexagon nuts, U.S.S. and S.A.E., all sizes	60, 20 and 10
Stove bolts in packages, nuts attached	75
Stove bolts in packages, with nuts separate	75 and 5
Stove bolts in bulk	82½
Tire bolts	50 and 5

On stove bolts freight is allowed to destination on 200 lb. and over.

Large Rivets

(½-in. and larger)

	Base per 100 Lb.
F.o.b. Pittsburgh or Cleveland	$3.05
F.o.b. Chicago or Birmingham	3.15

Small Rivets

(7/16-in. and smaller)

	Per Cent Off List
F.o.b. Pittsburgh	70 and 5
F.o.b. Cleveland	70 and 5
F.o.b. Chicago and Birm'g'm.	70 and 5

Cap and Set Screws

(Freight allowed up to but not exceeding 65c. per 100 lbs. on lots of 200 lb. or more)

	Per Cent Off List
Milled cap screws, 1 in. dia. and smaller	80, 10 and 10
Milled standard set screws, case hardened, 1 in. dia. and smaller	75
Milled headless set screws, cut thread ¾ in. and smaller	75
Upset hex. head cap screws U.S.S. or S.A.E. thread, 1 in. and smaller	60
Upset set screws, cup and oval points	75
Milled studs	65 to 65 and 10

Alloy and Stainless Steel

Alloy Steel Blooms, Billets and Slabs

F.o.b. Pittsburgh, Chicago, Canton, Massillon, Buffalo, Bethlehem.
Base price, $51 a gross ton.

Alloy Steel Bars

F.o.b. Pittsburgh, Chicago, Buffalo, Bethlehem, Massillon or Canton.

Open-hearth grade, base	2.55c.
Delivered price at Detroit is	2.70c.

S.A.E. Series Numbers	Alloy Differential per 100 lb.
2000 (½% Nickel)	$0.25
2100 (2½% Nickel)	0.95
2300 (3½% Nickel)	1.50
2500 (5% Nickel)	2.25
3100 Nickel Chromium	0.55
3200 Nickel Chromium	1.35
3300 Nickel Chromium	3.80
3400 Nickel Chromium	3.20
4100 Chromium Molybdenum (0.15 to 0.25 Molybdenum)	0.50
4100 Chromium Molybdenum (0.25 to 0.40 Molybdenum)	0.70
4600 Nickel Molybdenum (0.20 to 0.30) Molybdenum (1.50 to 2.00 Nickel)	1.05
5100 Chromium Steel (0.60 to 0.90 Chromium)	0.35
5100 Chromium Steel (0.80 to 1.10 Chromium)	0.45
5100 Chromium Spring Steel	base
6100 Chromium Vanadium Bar	1.10c.
6100 Chromium Vanadium Spring Steel	0.70
Chromium Nickel Vanadium	1.40
Carbon Vanadium	0.85

These prices are for hot-rolled steel bars. The differential for most grades in electric furnace steel is 50c. higher. The differential for cold-drawn bars ½c. per lb. higher with separate extras. Blooms, billets and slabs under 4x4 in. or equivalent are sold on the bar base. Slabs with a section area of 16 in. and 2½ in. thick or over take the billet base. Sections 4x4 in. to 10x10 in. or equivalent carry a gross ton price, which is the net price for bars for the same analysis. Larger sizes carry extras.

Alloy Cold-Finished Bars

F.o.b. Pittsburgh, Chicago, Gary, Cleveland or Buffalo, 3.05c. base per lb. Delivered Detroit, 3.20c.

STAINLESS STEEL No. 302

(17 to 19% Cr, 7 to 9% Ni, 0.08 to 0.20% C.)

(Base Prices f.o.b. Pittsburgh)

	Per Lb.
Forging billets	19.55c.
Bars	23c.
Plates	26c.
Structural shapes	23c.
Sheets	33c.
Hot-rolled strip	20¾c.
Cold-rolled strip	27c.
Drawn wire	23c.

TOOL STEEL

	Base per Lb.
High speed	57½c.
High carbon chrome	37c.
Oil hardening	21c.
Special	19c.
Extra	15¾c.
Regular	12½c.

Prices for warehouse distribution to all points on or East of Mississippi River are 2c. a lb. higher. West of Mississippi quotations are 3c. a lb. higher.

British and Continental

BRITISH

Per Gross Ton
f.o.b. United Kingdom Ports

Based on Exchange rate as of Oct. 6

Ferromanganese, export	$45.58
Billets, open-hearth	29.74 to $31.01
Tin plate, per base box	4.74 to 4.84
Steel bars, open-hearth	39.87
Beams, open-hearth	38.61
Channels, open-hearth	39.87
Angles, open-hearth	38.61
Black sheets, No. 24 gage	51.66
Galvanized sheets, No. 24 gage	61.50

CONTINENTAL

Per Metric Ton, f.o.b. Continental Ports

Based on Exchange rate of Oct. 6

Billets, Thomas	$19.27
Wire rods, No. 5 B.W.G.	36.90
Steel bars, merchant	26.64
Sheet bars	19.68
Plate, ¼ in. and up	35.42
Plate, 3/16 in. and 5 mm.	34.85
Sheets, ⅛ in.	36.90
Beams, Thomas	25.58
Angles (Basic)	25.58
Hoops and strip base	32.79
Wire, plain, No. 8	44.03
Wire nails	47.15
Wire, barbed, 4 pt. No. 10 B.W.G.	71.74

IRON AND STEEL WAREHOUSE PRICES

PITTSBURGH

	Base per Lb.
Plates	3.25c.
Structural shapes	3.25c.
Soft steel bars and small shapes	3.15c.
Reinforcing steel bars	3.15c.
Cold-finished and screw stock:	
Rounds and hexagons	3.60c.
Squares and flats	3.60c.
Hot rolled strip incl. 3/16 in. thick, under 24 in. wide	3.30c.
Hoops	3.80c.
Hot-rolled annealed sheets (No. 24), 25 or more bundles	3.45c.
Galv. sheets (No. 24), 25 or more bundles	4.05c.
Hot-rolled sheets (No. 10)	3.05c.
Galv. corrug. sheets (No. 28), per square (more than 3750 lb.)	$3.77
Spikes, large	3.25c.

	Per Cent Off List
Track bolts, all sizes, per 100 count	60
Machine bolts, 100 count	65-5
Carriage bolts, 100 count	65-5
Nuts, all styles, 100 count	65-5
Large rivets, base per 100 lb.	$3.65
Wire, black, soft ann'l'd, base per 100 lb.	3.05c.
Wire, galv. soft, base per 100 lb.	3.40c.
Common wire nails, per keg	2.30c.
Cement coated nails, per keg.	2.30c.

On plates, structurals, bars, reinforcing bars, bands, hoops and blue annealed sheets, base applies to orders of 400 to 9999 lb.

*Delivered in Pittsburgh switching district.

CHICAGO

	Base per Lb.
Plates and structural shapes	3.30c.
Soft steel bars, rounds	3.20c.
Soft steel bars, squares and hexagons	3.35c.
Cold-fin. steel bars:	
Rounds and hexagons	3.75c.
Flats and squares	3.75c.
Hot-rolled strip	3.40c.
Hot-rolled annealed sheets (No. 24)	4.05c.
Galv. sheets (No. 24)	4.65c.
Spikes (keg lots)	3.85c.
Track bolts (keg lots)	4.85c.
Rivets, structural (keg lots)	3.80c.
Rivets, boiler (keg lots)	3.90c.

	Per Cent Off List
Machine bolts	*65
Carriage bolts	*65
Lag screws	*65
Hot-pressed nuts, sq. tap or blank	*65
Hot-pressed nuts, hex. tap or blank	*65
Hex. head cap screws	87½
Cut point set screws	75 and 10
Flat head bright wood screws	70
Spring cotters	55
Stove bolts in full packages	70
Rd. hd. tank rivets, 7/16 in. and smaller	57½
Wrought washers	$4.50 off list
Black ann'l'd wire per 100 lb.	$3.95
Com. wire nails, 50 kegs or more	2.40c.†
Cement c't'd nails, 50 kegs or more	2.40c.†

On plates, shapes, bars, hot-rolled strip and heavy hot-rolled sheets, the base applies on orders of 400 to 9999 lb. All prices are f.o.b. consumers' plants wihtin the Chicago switching district.

*These are quotations delivered to city trade for quantities of 100 lb. or more. For lots of less than 100 lb., the quotation is 65 per cent off. Discounts applying to country trade are 70 per cent off, f.o.b. Chicago, with full or partial freight allowed up to 50c. per 100 lb.

†Prices for city and suburbs only.

NEW YORK

	Base per Lb.
Plates, ¼ in. and heavier	3.50c.
Structural shapes	3.47c.
Soft steel bars, rounds	3.51c.
Iron bars, Swed. charcoal	6.75c. to 7.00c.
Cold-fin. shafting and screw stock:	
Rounds and hexagons	4.06c.
Flats and squares	4.06c.
Cold-rolled: strip, soft and quarter hard	3.36c.
Hoops	3.66c.
Bands	3.66c.
Hot-rolled sheets (No. 10)	3.15c. to 3.41c.
Hot-rolled ann'l'd sheets (No. 24*)	3.75c. to 4.10c.
Galvanized sheets (No. 24*)	4.10c. to 4.50c.
Long terne sheets (No. 24)	5.25c. to 5.35c.
Armco iron, galv, (No. 24†)	5.65c.
Toncan iron, galv. (No. 24†)	5.65c.
Galvannealed (No. 24†)	5.75c.
Armco iron, hot-rolled annealed (No. 24†)	5.10c.
Toncan iron, hot-rolled annealed (No. 24†)	5.10c.
Armco iron hot-rolled (No. 10†)	4.15c.
Toncan iron, hot-rolled (No. 10†)	4.15c.
Cold-rolled sheets (No. 20) less than 1000 lbs.	
Standard quality	4.65c.
Deep drawing	5.40c.
Stretcher leveled	5.40c.
SAE, 2300, hot-rolled	6.97c.
SAE, 3100, hot-rolled	5.37c.
SAE, 6100, hot-rolled, annealed	9.57c.
SAE, 2300, cold-rolled	8.03c.
SAE, 3100, cold-rolled, annealed	7.43c.
Floor plate ⅛ in. and heavier	5.30c.
Standard tool steel	11.25c.
Wire, black annealed (No. 9)	3.50c.
Wire, galv. (No. 9)	3.85c.
Tire steel, 1 x ½ in. and larger	3.85c.
Open-hearth spring steel	4.00c. to 10.00c.
Common wire nails, base per keg	$3.21

	Per Cent Off List
Machine bolts, square head and nut:	
All diameters	65 and 10
Carriage bolts, cut thread:	
All diameters	65 and 10

* No. 28 and lighter, 36 in. wide, 20c. higher per 100 lb.

† 125 lb. and more.

ST. LOUIS

	Base per Lb.
Plates and struc. shapes	3.55c.
Bars, soft steel (rounds and flats)	3.45c.
Bars, soft steel (squares, hexagons, ovals, half ovals and half rounds)	3.60c.
Cold-fin. rounds, shafting, screw stock	4.00c.
Hot-rolled annealed sheets (No. 24)	4.30c.
Galv. sheets (No. 24)	4.90c.
Hot-rolled sheets (No. 10)	3.40c.
Black corrug. sheets (No. 24)	4.30c.
*Galv. corrug. sheets	4.90c.
Structural rivets	4.15c.
Boiler rivets	4.25c.

	Per Cent Off List
Tank rivets, 7/16 in. and smaller.	55
Machine and carriage bolts, lag screws, fitting up bolts, bolt ends, plow bolts, hot-pressed nuts, square and hexagon, tapped or blank, semi-finished nuts; all quantities	65

*No. 26 and lighter take special prices.

PHILADELPHIA

	Base per Lb.
*Plates, ¼-in. and heavier	3.10c.
*Structural shapes	3.10c.
*Soft steel bars, small shapes, iron bars (except bands)	3.25c.
‡Reinforc. steel bars, sq. twisted and deformed	3.01c.
Cold-finished steel bars	4.01c.
*Steel hoops	3.55c.
*Steel bands, No. 12 and 3/16 in. incl.	3.30c.
Spring steel	5.00c.
†Hot-rolled anneal. sheets (No. 24)	3.85c.
†Galvanized sheets (No. 24)	4.50c.
*Hot-rolled annealed sheets (No. 10)	3.20c.
Diam. pat. floor plates, ¼ in.	5.05c.
Swedish iron bars	6.25c.

These prices are subject to quantity differential except on reinforcing and Swedish iron bars.

*Base prices subject to deduction on orders aggregating 4000 lb. or over.

†For 25 bundles or over.

‡For less than 2000 lb.

CLEVELAND

	Base per Lb.
Plates and struc. shapes	3.41c.
Soft steel bars	3.10c.
‡Reinforc. steel bars	2.10c.
†Cold-finished steel bars	3.75c.
Flat-rolled steel under ¼ in.	3.46c.
Cold-finished strip	†3.00c.
Hot-rolled annealed sheets (No. 24)	3.91c.
Galvanized sheets (No. 24)	4.61c.
Hot-rolled sheets (No. 10)	3.21c.
Hot-rolled 3/16 in. 24 to 48 in. wide sheets	3.46c.
*Black ann'l'd wire, per 100 lb.	$2.80
*No. 9 galv. wire, per 100 lb.	3.15
*Com. wire nails, base per keg	2.25

†Outside delivery 10c. less.

*For 5000 lb. or less.

‡Plus switching and cartage charges and quantity differentials up to 50c.

CINCINNATI

	Base per Lb.
Plates and struc. shapes	3.52c.
Floor plates	5.27c.
Bars, rounds, flats and angles	3.42c.
Other shapes	3.57c.
Rail steel reinforc. bars	3.25c.
Hoops and bands, 3/16 in. and lighter	3.57c.
Cold-finished bars	3.97c.
Hot-rolled annealed sheets (No. 24) 25 bundles or more	3.72c.
Galv. sheets (No. 24) 3750 lb. or more	4.07c.
Galvanized sheets (No. 24) over 3500 lb.	4.07c.
Hot-rolled sheets (No. 10)	3.32c.
Structural rivets	4.50c.
Small rivets	55 per cent off list
No. 9 ann'l'd wire, per 100 lb. (1000 lb. or over)	$2.88
Com. wire nails, base per keg:	
Any quantity less than carload.	3.04
Cement c't'd nails, base 100-lb keg	3.50
Chain, lin. per 100 lb	8.35

	Net per 100 Ft.
Seamless steel boiler tubes, 2-in.	$20.37
4-in.	48.14
Lap-welded steel boiler tubes, 2-in.	19.38
4-in.	45.32

BUFFALO

	Base per Lb.
Plates	3.48c.
Struc. shapes	3.35c.
Soft steel bars	3.25c.
Reinforcing bars	2.60c.
Cold-fin. flats and sq.	3.80c.
Rounds and hex.	3.80c.
Cold-rolled strip steel	3.19c.
Hot-rolled annealed sheets (No. 24)	4.26c.
Heavy hot-rolled sheets (3/16 in., 24 to 48 in. wide)	3.53c.
Galv. sheet (No. 24)	4.80c.
Bands	3.53c.
Hoops	3.53c.
Heavy top-rolled sheets	3.28c.
Com. wire nails, base per keg.	$2.85
Black wire, base per 100 lb. (2500-lb. lots or under)	4.00
(Over 2500 lb.)	3.90

BOSTON

	Base per Lb.
Beams, channels, angles	3.65c.
Tees and zees, under 3"	3.90c.
H beams and shapes	3.64c.
Plates — Sheared, tank, and univ. mill, ¼ in. thick and heavier	3.66c.
Floor plates, diamond pattern	5.46c.
Bar and bar shapes (mild steel)	3.65c.
Bands 3/16 in. thick and No. 12 ga. incl.	3.75c. to 4.75c.
Half rounds, half ovals, ovals and bevels	4.90c.
Tire steel	4.90c.
Cold-rolled strip steel	3.10c.
Cold-finished rounds, squares and hexagons	4.10c.
Cold-finished flats	4.10c.
Blue annealed sheets, No. 10 ga.	3.75c.
One pass cold-rolled sheets No. 24 ga.	4.30c.
Galvanized steel sheets, No. 24 ga.	4.30c.
Lead coated sheets, No. 24 ga.	5.85c.

Price delivered by truck in metropolitan Boston, subject to quantity differentials.

DETROIT

	Base per Lb.
Soft steel bars	3.29c.
Structural shapes	3.52c.
Plates	3.52c.
Floor plates	5.27c.
Hot-rolled annealed sheets (No. 24)*	4.14c.
Hot-rolled sheets (No. 10)**	3.24c.
Galvanized sheets (No. 24)	4.82c.
Bands	3.49c.
Hoops	3.49c.
†Cold-finished bars	3.84c.
Cold-rolled strip	3.18c.
Hot-rolled alloy steel (S.A.E. 3100 Series)	5.44c.
Bolts and nuts, in cases, 70 and 10 per cent off list	
Broken cases...65 and 10 per cent off	

Prices delivered by truck in metropolitan Detroit, subject to quantity differentials covering shipment at one time.

* Base less 0.25c., 3500 lb. and over. Add 0.50c. per hundred lb. for broken bundles.

** Base less 0.25c., 1500 to 3749 lbs.; less 0.50c., 3750 to 7499 lb.; less 0.75c., 7500 lb. and over.

Galvanized and hot-rolled annealed may not be combined to obtain quantity deductions.

Country territory to be equalized on the Chicago plan.

MILWAUKEE

	Base per Lb.
Plates and structural shapes	3.41c.
Soft steel bars, rounds up to 8 in., flats and fillet angles	3.31c.
Soft steel bars, squares and hexagons	3.46c.
Hot-rolled strip	3.51c.
Hot-rolled sheets (No. 10)	3.26c.
Hot-rolled annealed sheets (No. 24)	4.16c.
Galvanized sheets (No. 20)	4.76c.
Cold-finished steel bars	3.76c.
Cold-rolled strip	3.33c.
Structural rivets (keg lots)	4.01c.
Boiler rivets, cone head (keg lots)	4.11c.
Track spikes (keg lots)	4.06c.
Track bolts (keg lots)	5.06c.
Black annealed wire	3.40c.
Com. wire nails	2.60c.
Cement coated nails	2.60c.

	Per Cent Off List
Machine bolts, carriage bolts and lag screws	70 to 75
Hot-pressed nuts, sq. and hex. tapped or blank (keg lots)	70

Prices given above are delivered Milwaukee.

On plates, shapes, bars, hot-rolled strip and heavy hot-rolled sheets, the base applies on orders of 400 to 9999 lb. On galvanized and No. 24 hot-rolled annealed sheets the prices given apply on orders of 400 to 1500 lb. On cold-finished bars the prices are for orders of 1000 lb. or more of a size.

ST. PAUL

	Base per Lb.
Mild steel bars, rounds	3.45c.
Structural shapes	3.55c.
Plates	3.55c.
Cold-finished bars	4.00c.
Bands and hoops	3.65c.
Hot-rolled annealed sheets, No. 24	4.30c.
Galvanized sheets, No. 24	4.90c.

On mild steel bars, shapes, plates and hoops and bands the base applies on 400 to 14,999 lb. On hot-rolled sheets, galvanized sheets and cold-rolled sheets base applies on 15,000 lb. and over. Base on cold-finished bars is 1000 lb. and over of a size.

BALTIMORE

	Base per Lb.
Mild Steel bars and small shapes	3.10c.
Structural shapes	3.10c.
Reinforcing bars	....prices on application
Plates	3.10c.
Hot-rolled sheets, No. 10	3.20c.
Bands	3.30c.
Hoops	3.55c.
Special threading steel	3.20c.
Diamond pattern floor plates ¼ in. and heavier	5.10c.
Galvanized bars and small shapes	5.60c.
Galvanized bands	5.80c.
Cold-rolled rounds, hexagons, squares and flats, 1000 lb. and more	3.88c.

All prices are for 2000 lb. and more.

For second zone add 10c. per 100 lb. for trucking.

List size extras of Aug. 15, 1935, and cutting extras to be added.

For cold-rolled products, list size extras from Jan. 1, 1936, and cutting extras to be added.

CHATTANOOGA

	Base per Lb.
Mild steel bars	3.46c.
Iron bars	3.46c.
Reinforcing bars	3.46c.
Structural shapes	3.66c.
Plates	3.66c.
Hot-rolled sheets No. 10	3.46c.
Hot-rolled annealed sheets No. 24*	3.41c.
Galvanized sheets, No. 24*	3.96c.
Steel bands	3.71c.
Cold-finished bars	4.281c.

* Plus mill item extra.

MEMPHIS

	Base per Lb.
Mild steel bars	3.57c.
Shapes, bar size	3.57c.
Iron bars	3.57c.
Structural shapes	3.77c.
Plates	3.77c.
Hot-rolled sheets, No. 10	3.57c.
Hot-rolled annealed sheets, No. 24	4.37c.
Galvanized sheets, No. 24	5.07c.
Steel bands	3.82c.
Cold-drawn rounds	4.04c.
Cold-drawn flats, squares, hexagons	6.04c.
Structural rivets	4.25c.
Bolts and nuts, per cent off list	65
Small rivets, per cent off list.	50

NEW ORLEANS

	Base per Lb.
Mild steel bars	3.45c.
Reinforcing bars	3.50c.
Structural shapes	3.65c.
Plates	3.65c.
Hot-rolled sheets, No. 10	3.65c.
Hot-rolled annealed sheets, No. 24	4.35c.
Galvanized sheets, No. 24	4.95c.
Steel bands	4.05c.
Cold-finished steel bars	4.55c.
Structural rivets	4.25c.
Boiler rivets	4.25c.
Common wire nails, Base per keg	$2.45
Bolts and nuts, per cent off list	70

PACIFIC COAST

	Base per Lb. San Francisco	Los Angeles	Seattle
Plates, tank and U. M.	3.60c.	3.80c.	3.75c.
Shapes, standard	3.60c.	3.80c.	3.75c.
Soft steel bars	3.60c.	3.80c.	3.75c.
Reinforcing bars, f.o.b. cars dock			
Pacific ports	2.45c.	2.45c.	2.45c.
Hot-rolled annealed sheets (No. 24)	4.30c.	4.35c.	4.30c.
Hot-rolled sheets (No. 10)	3.70c.	3.90c.	3.85c.
Galv. sheets (No. 24 and lighter)	5.00c.	4.60c.	4.60c.
Galv. sheets (No. 22 and heavier)	5.00c.	4.80c.	5.10c.
Cold finished steel			
Rounds	6.05c.	6.10c.	6.00c.
Squares and hexagons	7.30c.	7.35c.	7.25c.
Flats	7.80c.	7.85c.	8.25c.
Common wire nails—base per keg less carload	$2.90	$2.90	$2.90

All items subject to differentials for quantity.

REFRACTORIES PRICES

Fire Clay Brick

	Per 1000 f.o.b Works
High-heat duty, Pennsylvania, Maryland, Kentucky, Missouri and Illinois	$45.00
High-heat duty, New Jersey	50.00
High-heat duty, Ohio	40.00
Intermediate, Pennsylvania, Maryland, Kentucky, Missouri and Illinois	40.00
Intermediate, New Jersey	43.00
Intermediate, Ohio	35.00
Ground fire clay, per ton	7.00

Silica Brick

	Per 1000 f.o.b Works
Pennsylvania	$45.00
Chicago District	54.00
Birmingham	$48 to 50.00
Silica cement per net ton	8.00

Chrome Brick

	Per Net Ton
Standard f.o.b. Baltimore, Plymouth Meeting and Chester	$45.00
Chemically bonded f.o.b. Baltimore, Plymouth Meeting and Chester, Pa.	45.00

Magnesite Brick

	Per Net Ton
Standard f.o.b. Baltimore and Chester, Pa.	$65.00
Chemically bonded, f.o.b. Baltimore	55.00

Grain Magnesite

	Per Net Ton
Imported, f.o.b. Baltimore and Chester, Pa. (in sacks)	$45.00
Domestic, f.o.b. Baltimore and Chester, in sacks	40.00
Domestic, f.o.b. Chewelah, Wash.	22.00

RAW MATERIALS PRICES

PIG IRON

No. 2 Foundry

F.o.b. Everett, Mass.; Bethlehem, Birdsboro and Swedeland, Pa., and Sparrows Point, Md.	$20.50
Delivered Brooklyn	22.9289
Delivered Newark or Jersey City	21.9873
Delivered Philadelphia	21.3132
F.o.b. Neville Island, Sharpsville and Erie, Pa.; Buffalo; Youngstown, Cleveland, Toledo and Hamilton, Ohio; Detroit; Chicago and Granite City, Ill.	19.50
F.o.b. Jackson, Ohio	21.25
Delivered Cincinnati	19.82
F.o.b. Duluth	20.00
F.o.b. Provo, Utah	17.50
Delivered San Francisco, Los Angeles or Seattle	22.315
F.o.b. Birmingham*	15.88

* Delivered prices on southern iron for shipment to northern points are 38c. a ton below delivered prices from nearest northern basing point on iron with phosphorus content of .70 and over.

Malleable

Base prices on malleable iron are 50c. a ton above No. 2 foundry quotations at Everett, Eastern Pennsylvania furnaces, Erie and Buffalo. Elsewhere they are the same.

Basic

F.o.b Everett, Mass.; Bethlehem, Birdsboro, Swedeland and Steelton, Pa., and Sparrows Point, Md.	$20.00
Delivered Boston Switching District	20.50
Delivered Newark or Jersey City	21.4873
Delivered Philadelphia	20.8132
F.o.b. Buffalo	18.50
F.o.b. Neville Island, Sharpsville and Erie, Pa.; Youngstown, Cleveland, Toledo and Hamilton, Ohio; Detroit; Chicago and Granite City, Ill.	19.00
Delivered Cincinnati	18.82
Delivered Canton, Ohio	20.3482
Delivered Mansfield, Ohio	20.8832
F.o.b. Jackson, Ohio	20.75
F.o.b. Provo, Utah	17.00
F.o.b. Birmingham	14.50

Bessemer

F.o.b. Everett, Mass.; Bethlehem, Birdsboro and Swedeland, Pa.	$21.50
Delivered Boston Switching District	22.00
Delivered Newark or Jersey City	22.9873
Delivered Philadelphia	22.3132
F.o.b. Buffalo and Erie, Pa., and Duluth	20.50
F.o.b. Neville Island and Sharpsville, Pa.; Youngstown, Cleveland, Toledo and Hamilton, Ohio; Detroit; Chicago	20.00
F.o.b. Birmingham	21.00
Delivered Cincinnati	21.0807
Delivered Canton, Ohio	21.3482
Delivered Mansfield, Ohio	21.8832

Low Phosphorus

Basing points: Birdsboro, Pa., Steelton, Pa., and Standish, N. Y.	$24.00

Gray Forge

Valley or Pittsburgh furnace	$19.00

Charcoal

Lake Superior furnace	$22.50
Delivered Chicago	25.7528

Canadian Pig Iron

Per Gross Ton

Delivered Toronto

No. 1 fdy., sil. 2.25 to 2.75	$21.00
No. 2 fdy., sil. 1.75 to 2.75	20.50
Malleable	22.50

Delivered Montreal

No. 1 fdy., sil. 2.25 to 2.75	$22.50
No. 2 fdy., sil. 1.75 to 2.25	22.00
Malleable	22.50
Basic	22.00

FERROALLOYS

Ferromanganese

F.o.b. New York, Philadelphia, Baltimore, Mobile or New Orleans.

Per Gross Ton

Domestic, 80% (carload)	$75.00

Spiegeleisen

Per Gross Ton Furnace

Domestic, 19 to 21%	$26.00
50-ton lots 3-mo. shipment	24.00
F.o.b. New Orleans	26.00

Electric Ferrosilicon

Per Gross Ton Delivered

50% (carloads)	$69.50
50% (ton lots)	77.00
75% (carloads)	126.00
75% (ton lots)	136.00

Silvery Iron

Per Gross Ton

F.o.b. Jackson, Ohio, 6.00 to 6.50%	$22.75

For each additional 0.5% silicon up to 17%, 50c. a ton is added.

The lower all-rail delivered price from Jackson or Buffalo is quoted with freight allowed. Base prices at Buffalo are $1.25 a ton higher than at Jackson.

Manganese 2 to 3%, $1 a ton additional. For each unit of manganese over 3%, $1 a ton additional. Phosphorus 0.75% or over, $1 a ton additional.

Bessemer Ferrosilicon

F.o.b. Jackson, Ohio, Furnace

Per Gross Ton

10.00 to 10.50%	$27.75
10.51 to 11.00%	28.25
11.00 to 11.50%	28.75
11.51 to 12.00%	29.25
12.01 to 12.50%	29.75
12.51 to 13.00%	30.25
13.01 to 13.50%	30.75
13.51 to 14.00%	31.25
14.01 to 14.50%	31.75
14.51 to 15.00%	32.25
15.01 to 15.50%	32.75
15.51 to 16.00%	33.25
16.01 to 16.50%	33.75
16.51 to 17.00%	34.25

Manganese 2 to 3%, $1 a ton additional. For each unit of manganese over 3%, $1 a ton additional. Phosphorus 0.75% or over, $1 a ton additional.

Base prices at Buffalo are $1.25 a ton higher than at Jackson.

Other Ferroalloys

Ferrotungsten, per lb. contained W del., carloads	$1.30
Ferrotungsten, lots of 5000 lb.	1.35
Ferrotungsten, smaller lots	1.40
Ferrochromium, 4 to 6% carbon and up, 65 to 70% Cr per lb. contained Cr delivered, in carloads, and contract	10.00c.
Ferrochromium, 2% carbon	16.50c. to 17.00c.
Ferrochromium, 1% carbon	17.50c. to 18.00c.
Ferrochromium, 0.10% carbon	19.50c. to 20.00c.
Ferrochromium, 0.06% carbon	20.00c. to 20.50c.
Ferrovanadium, del. per lb. contained V.	$2.70 to $2.90
Ferrocolumbium, per lb. contained columbium, f.o.b. Niagara Falls, N. Y.	$2.50
Ferrocarbontitanium, 15 to 18% Ti, 7 to 8% C, f.o.b. furnace carload and contract per net ton	$137.50
Ferrocarbontitanium, 17 to 20% Ti, 3 to 5% C, f.o.b. furnace, carload and contract, per net ton	142.50
Ferrophosphorus, electric, or blast furnace material, in carloads, f.o.b. Anniston, Ala., for 18%, with $3 unitage, freight equalized with Rockdale, Tenn., per gross ton	58.50
Ferrophosphorus, electric, 24%, in carlots, f.o.b. Anniston, Ala., per gross ton with $3 unitage, freight equalized with Nashville, Tenn.	75.00
Ferromolybdenum, per lb. Mo del.	95c.
Calcium molybdate, per lb. Mo del.	80c.
Silico spiegel, per ton, f.o.b. furnace, carloads	$38.00
Ton lots or less, per ton	43.00
Silico-manganese, gross ton, delivered.	
2.50% carbon grade	85.00
2% carbon grade	90.00
1% carbon grade	100.00

Note: Spot prices are $5 a ton higher except on 75 per cent ferrosilicon on which premium is $10 a ton.

ORES

Lake Superior Ores

Delivered Lower Lake Ports

Per Gross Ton

Old range, Bessemer, 51.50%	$4.80
Old range, non-Bessemer, 51.50%	4.65
Mesabi, Bessemer, 51.50%	4.65
Mesabi, non-Bessemer, 51.50%	4.50
High phosphorus, 51.50%	4.40

Foreign Ore

C.i.f. Philadelphia or Baltimore

Per Unit

Iron, low phos., copper free, 55 to 58% dry Algeria	12.50c.
Iron, low phos., Swedish, average, 68½% iron	Nominal
Iron, basic or foundry, Swedish, aver. 65% iron	9.50c.
Iron, basic or foundry, Russian, aver. 65% iron	Nominal
Man., Caucasian, washed 52%.	27c.
Man., African, Indian, 44-48%.	25c.
Man., African, Indian, 49-51%.	26c.
Man., Brazilian, 46 to 48½%	Nominal 25c.

Per Net Ton Unit

Tungsten, Chinese, wolframite, duty paid delivered nominal	$15.25 to $15.50
Tungsten, domestic, scheelite delivered, nominal	15.00

Per Gross Ton

Chrome, 45% Cr_2O_3, lump, c.i.f. Atlantic Seaboard (African)	$17.50
45 to 46% Cr_2O_3 (Turkish)	$16.50 to 17.00
48% Cr_2O_3 (African)	20.50
48% min. Cr_2O_3 (Turkish)	19.25
Chrome concentrate, 50% and over Cr_2O_3, c.i.f. Atlantic ports	22.00
52% Cr_2O_3 (Turkish)	21.75
48 to 49% Cr_2O_3 (Turkish)	19.25

FLUORSPAR

Per Net Ton

Domestic, washed gravel, 85-5, f.o.b. Kentucky and Illinois mines, all rail	$18.00
Domestic, barge and rail	18.50
No. 2 lump, 85-5, f.o.b. Kentucky and Illinois mines	19.00
Foreign, 85% calcium fluoride, not over 5% silicon, c.i.f. Atlantic ports, duty paid	22.00
Domestic No. 1 ground bulk, 95 to 98% calcium fluoride, not over 2½% silicon, f.o.b. Illnois and Kentucky mines	35.00

FUEL OIL

Per Gal.

F.o.b. Bayonne or Baltimore No. 3 distillate	4.25c.
F.o.b. Bayonne or Baltimore, No. 4 industrial	3.75c.
Del'd Ch'go, No. 3 industrial	5.00c.
Del'd Ch'go, No. 5 industrial	3.77c.
Del d Cleve'd, No. 3 distillate	5.75c.
Del'd Cleve'd No. 4 industrial	5.50c.
Del'd Cleve'd No. 5 industrial	5.00c.

COKE AND COAL

Coke

Per Net Ton

Furnace, f.o.b. Connellsville, Prompt	$3.75 to $4.00
Foundry, f.o.b. Connellsville, Prompt	4.25 to 5.75
Foundry, by-product, Chicago ovens	9.00
Foundry, by-product, del'd New England	11.50
Foundry, by-product, del'd Newark or Jersey City	9.60 to 10.05
Foundry, by-product, Philadelphia	9.38
Foundry, by-product, delivered Cleveland	9.75
Foundry, by-product, delivered Cincinnati	9.50
Foundry, Birmingham	6.50
Foundry, by-product, St. Louis, f.o.b. ovens	8.00
Foundry, from Birmingham, f.o.b. cars docks, Pacific ports	14.75

Coal

Per Net Ton

Mine run steam coal, f.o.b. W. Pa. mines	$1.50 to $1.75
Mine run coking coal, f.o.b. W. Pa.	1.75 to 1.90
Gas coal, ¾-in. f.o.b. Pa. mines	2.00 to 2.25
Mine run gas coal, f.o.b. Pa. mines	1.80 to 2.00
Steam slack, f.o.b. W. Pa. mines	1.00 to 1.25
Gas slack, f.o.b. W. Pa. mines	1.20 to 1.45

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BRAND
FERRO – ALLOYS

For High Quality Steels

FERRO SILICON
ALL GRADES

FERRO CHROMIUM
HIGH CARBON

FERRO CHROMIUM
LOW CARBON

FERRO MANGANESE

SILICO MANGANESE

PITTSBURGH METALLURGICAL CO., Inc.

NIAGARA FALLS, N. Y.

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FABRICATED STEEL

. . . Lettings slightly higher at 14,000 tons compared with 13,900 tons last week.

o o o

. . . New projects rise to 23,260 tons from 13,225 tons a week ago.

NORTH ATLANTIC STATES

Brooklyn, 680 tons, Brooklyn State Hospital building, to Ingalls Iron Works Co.

Jersey City, 210 tons, building, Bergen Avenue and Montgomery Street, to Lehigh Structural Steel Co., Allentown, Pa.

Philadelphia, 120 tons, market house, to Morris Wheeler Co., Philadelphia.

Bedford County, Pa., 170 tons, State highway bridge, to Pittsburgh-Des Moines Steel Co.

Buffalo, 1200 tons, Linde Air Products research laboratory and office building, to American Bridge Co.

Crittenden, N. Y., 174 tons, New York Central grade elimination, to Lackawanna Steel Construction Co.

Rochester, N. Y., 870 tons, grade crossing elimination, to Bethlehem Steel Co.

South Amboy, N. J., 550 tons, railroad bridge, to Bethlehem Steel Co.

Dover, N. J., 250 tons, high school, to Breen Iron Works.

Camden, N. J., 165 tons, RCA Victor Mfg. Co., boiler house addition, to Bethlehem Steel Co.

McKeesport, Pa., 310 tons, McKeesport Daily News building, to Ingalls Iron Works Co.

McKeesport, 1475 tons, Jerome Street bridge, to Fort Pitt Bridge Works Co.

SOUTH AND SOUTHWEST

Brownsville, Tenn., 308 tons, bridge, to Nashville Bridge Co.

Shelby County, Tenn., 238 tons, bridge, to Nashville Bridge Co.

Shelby County, Tenn., 145 tons, bridge, to Virginia Bridge Co.

Thornton, W. Va., 375 tons, overhead crossing, to American Bridge Co.

Newburg, W. Va., 225 tons, bridge, to Fort Pitt Bridge Works Co.

Welch, W. Va., 135 tons, coal cleaning plant, to Lackawanna Steel Construction Co.

Mercer County, W. Va., 145 tons, State highway bridge, to Virginia Bridge Co., Roanoke, Va.

Coahoma County, Miss., 240 tons, railroad bridge, to Bethlehem Steel Corp.

Lee County, Miss., 115 tons, bridge, to Virginia Bridge Co.

Baton Rouge, La., 530 tons, law school building, to Jones & Laughlin Steel Corp.

Yuma, Ariz., 300 tons, overchutes, turnouts, inlets for All-American Canal, to an unnamed bidder.

Dallas, Tex., 375 tons, Phoenix Engineering Co., to Virginia Bridge Co.

CENTRAL STATES

Kalamazoo, Mich., 275 tons, bridge, to American Bridge Co.

Detroit, 380 tons, manufacturing and office building for Herronzimmers Mould Co., to Fort Pitt Bridge Works Co.

White Pigeon, Mich., 190 tons, building for Eddy Paper Co., to Jarvis Engineering Works.

Youngstown, 280 tons, mill building for Youngstown Sheet & Tube Co., to Fort Pitt Bridge Works Co.

Cleveland, 280 tons, sewage treatment works, to Fort Pitt Bridge Works Co.

East Chicago, Ind., 444 tons, high school, to United Boiler & Heating Co.

Valparaiso, Ind., 147 tons, court house, to American Bridge Co.

Chicago, 650 tons, underpass, to R. C. Mahon Co.

Milwaukee, 250 tons, St. John's Cathedral, to Milwaukee Structural Steel Co.

State of Wisconsin, 900 tons, bridge, to Midland Structural Steel Co.

Chicago & North Western, 400 tons, bridge, to American Bridge Co.

WESTERN STATES

Fife, Wash., 100 tons, State overcrossing, to an unnamed bidder.

Olympia, Wash., 105 tons, addition to brewery, to Isaacson Iron Works.

Seattle, 200 tons, Acme Paving Co. project, to Pacific Car & Foundry Co.

Los Angeles, 100 tons, addition to glass factory, to Bethlehem Steel Co.

Los Angeles, 250 tons, gate hoist for United States Engineers, to Consolidated Steel Corp.

Alaska, 100 tons, three bridges, to Pacific Car & Foundry Co.

NEW STRUCTURAL STEEL PROJECTS

NORTH ATLANTIC STATES

Lisborn-Durham, Me., 300 tons, State bridge over Androscoggin River.

Brattleboro, Vt., 100 tons, State bridge.

Somerville, Mass., 400 tons, assembly plant addition for Ford Motor Co.

New York, 4300 tons, Sixth Avenue subway, section 11.

New York, 1000 tons, Riverside Drive apartment house.

Ferndale, Pa., 200 tons, highway bridge.

Savona, N. Y., 100 tons, bridge.

Butler County, Pa., 770 tons, State bridge; bids Oct. 23.

Cambria County, Pa., 400 tons, bridge; bids Oct. 23.

Tioga County, Pa., 200 tons, bridge; bids Oct. 23.

Centre County, Pa., 110 tons, bridge; bids Oct. 16.

Elk County, Pa., 120 tons, bridge; bids Oct. 16.

Huntingdon County, Pa., 200 tons, bridge; bids Oct. 16.

Luzerne County, Pa., 1200 tons, viaduct; bids Oct. 16.

THE SOUTH

Wheeling, W. Va., 2500 tons, extension to building, Wheeling Steel Corp.

Baton Rouge, La., 1000 tons, E. I. du-Pont de Nemours plant.

CENTRAL STATES

Royal Oak, Mich., 140 tons, Montgomery Ward store.

State of Michigan, 3000 tons, ice breaker.

Flint, Mich., 250 tons, warehouse and storage buildings, A. C. Spark Plug Co.

Cleveland, 150 tons, State highway garage; bids taken.

State of Ohio, 450 tons, Crawford County bridges; bids Oct. 20.

Bellevue, Ohio, 220 tons, grade crossing elimination; bids taken.

Cincinnati, 2650 tons, viaduct.

East Grand Forks, Minn., 350 tons, bridge.

Crescent, Iowa, 400 tons, bridge over Pigeon Creek.

WESTERN STATES

Routt County, Colo., 100 tons, three bridges; bids Oct. 20.

Denver, 1200 tons, railroad overpass; bids Oct. 20.

Los Angeles, 20,000 tons, post office and courthouse; bids advanced to Oct. 22.

Potholes, Cal., 1000 tons, radial gates Imperial Dam, Bureau of Reclamation.

State of California, 450 tons, trash racks for Bureau of Reclamation.

FABRICATED PLATES

AWARDS

Pittsburgh, 3800 tons, 25 standard steel riveted and welded coal barges for Carnegie-Illinois Steel Corp., to American Bridge Co.

Newport News, Va., 156 tons, pressure gas tank for Utilities Purchasing & Supply Corp., to an unnamed fabricator.

Memphis, Tenn., 420 tons, pontoons for United States Engineers, to St. Louis Shipbuilding Co.

Smith's Bluff, Tex., 540 tons, tanks for Pure Oil Co., to Chicago Bridge & Iron Works.

Milwaukee, 1250 tons, 96 tanks for Anheuser-Busch, Inc., to A. O. Smith Corp.

Milwaukee, 250 tons, tanks for Fred Miller Brewing Co., to Cream City Boiler Co., Milwaukee.

Beaver Dam, Wis., 400,000-gal. elevated water tank, to Pittsburgh-Des Moines Steel Co.

SHEET PILING

AWARDS

Buffalo, 891 tons, Bird Island sewage disposal project, to Carnegie-Illinois Steel Corp.

Milwaukee, 135 tons, Twelfth Lighthouse District Office, to Bethlehem Steel Co.

Bracburn, Pa., 477 tons, dam in Allegheny River, to Jones & Laughlin Steel Corp.

Buffalo, 892 tons, sewage disposal plant, to Carnegie-Illinois Steel Corp.

Potholes, Cal., 150 tons, All American Canal project, to Carnegie-Illinois Steel Corp.

NEW PROJECTS

Potholes, Cal., 450 tons, All American Canal, United States Bureau of Reclamation.

THIS WEEK'S MACHINE TOOL ACTIVITIES

. . . Machinery orders hold reasonably well.

o o o

. . . Mid-western buying shows improvement.

o o o

. . . New inquiries are generally active.

o o o

By L. M. WAITE

o o o

THERE appears to be no evidence that a national political campaign is detracting from sincere interest in machine tools. Although the automotive industry is at present a minor factor in orders, other industries and particularly small-shop buyers are sustaining the order averages of the past three or four months to a very reasonable extent. Purchasing of several machine units, rather than one only, has increased somewhat among medium-sized plants and additional proposals of this nature are said to be under active consideration. Special machines are receiving careful engineering attention in a number of instances and it is said that "try-out" competition will be the determining factor in the selection of machinery for two or three new production lines outside of the motor car field.

Chicago

THE tone of the local machine tool market is somewhat improved. Sales are climbing slowly and inquiries are being received in an encouraging volume. Farm implement manufacturers are studying appropriations for next year, but dealers expect that this outlet will be rather slow over the next six weeks to two months. Bucyrus Erie Co., South Milwaukee, Wis., is issuing formal inquiries for about $150,000 worth of machine tools.

New York

A GENERALLY satisfactory volume of orders is maintained well into October with, however, some indication of let-up in numbers as compared with the past three months. Both new and pending inquiries are heavy and lend to belief that while a temporary lull in buying may be in the making, such a development is merely a normal reaction to a political situation and to the closing of the year. Several new inquiries, said to involve considerable semi-special equipment for use with standard machines, are requiring both engineering and sales activity. It is held to be likely that a greater part of this business may be placed before the end of the year because of delivery conditions. Probable purchases on a sizable production program are said to be up to the point of final determination with respect to chucking machines. There appears to be no lack of optimism among sales organizations.

Pittsburgh

THERE has been no let-up in the volume of machine tool inquiries received by dealers in the past 10 days. Customers appear to be anxious for production data, and several attractive small lists are reported to be under consideration. Volume of orders is steady with likelihood of further increases, owing to the bulge in inquiries. Several mill crane projects are pending and in the past two weeks one mill has purchased a 4-ton crane while another plant closed a contract for a 10-ton outfit. Producers of mill equipment are extremely busy with the prospects for additional business said to be the brightest in some time.

Cleveland

TURRET lathes are in very good demand, sales showing quite a gain over the corresponding period of September. Single tool orders predominate. Manufacturers of most other lines of tools report good sales. Business with local dealers remains quiet. Presses are in good demand from makers of refrigerators and other household appliances, but little business is coming at present from the motor car industry. Orders from this source are expected to increase when automobile manufacturers get under good production on new models.

Cincinnati

SMALL orders for standard machine tools are well sustained, but new market developments are lacking. Special-tool interest is diminishing, but this is offset by requirements of regular machinery. A recent multiple-unit lathe inquiry from an agricultural implement manufacturer is still current, and local builders anticipate an early closing.

Inquiry of earnest nature is steadily active. Closing on quotations, however, is slow, users reported to be watching appropriations carefully. Local manufacturers indicate outstanding quotations to be large. Deliveries are still troublesome.

Boston

MACHINE tool activity in this area continues. A number of new inquiries which have a bearing on early 1937 buying have appeared. Several pending inquiries have taken on new life because of delivery conditions and there is some expectancy of late October business from this source. In some quarters delivery is being awaited on special machines the production abilities of which will have a direct bearing on the type of machines to be ordered for production lines. Orders for standard machines are closing gradually and impression prevails that this type of business will continue throughout the fall in moderate volume.

Detroit

DELIVERY of machinery on new production lines is still taking the attention of most dealers and factory representatives in this area. The situation is particularly acute at Oldsmobile's factory in Lansing, which was late in entering the market for equipment on the new motor line. Because of the delivery situation, it is hoped that inquiries will come out much earlier for machinery needed on next year's models. Some prints on 1938 parts are already in the hands of machinery builders for initial proposals, although it is expected that no business will begin to materialize for several months.

Miscellaneous inquiries are holding up fairly well. Small shops and jobbing shops are expected to be an increasingly important factor in the market for standard machine tools, particularly of the toolroom type.

PLANT EXPANSION AND EQUIPMENT BUYING

NORTH ATLANTIC

Linde Air Products Co., 30 East Forty-second Street, New York, manufacturer of acetylene welding and cutting equipment, brazing equipment, etc., has let general contract to John W. Cowper Co., Buffalo, for initial units of new plant at Tonawanda, N. Y., comprising main one-story manufacturing building, 100,000 sq. ft. floor space, one-story laboratory, boiler plant and two-story office. Other structures will be built later. Cost is estimated at about $1,000,000 with machinery.

Oswego Falls Corp., Fulton, N. Y., manufacturer of paperboard and wood pulp board products, has let general contract to H. K. Ferguson Co., Cleveland, for one-story mill addition. Cost over $50,000 with equipment.

Bureau of Supplies and Accounts, Navy Department, Washington, asks bids until Oct. 20 for steel forgings for shafting (Schedule 8960), converter units and spare parts (Schedule 8956) for Brooklyn Navy Yard; eight 4-ton and 12 2-ton chain hoists, and eight 1-ton and eight ½-ton chain hoists (Schedule 8983), wind intensity and wind direction indicating equipment (Schedule 8981), five hand-power sheet metal-working machines (Schedule 9021) for Brooklyn and Philadelphia yards.

H. H. Bell Steel Co., 52 Laight Street, New York, has purchased five-story building at 727-29 Washington Street, 36 x 100 ft., and will remodel for new storage and distributing plant.

Bayer Co., Inc., 170 Varick Street, New York, manufacturer of chemical products, has let general contract to W. G. Sheehan Construction Co., Inc., 28 DeWitt Street, Albany, N. Y., for two additions to plant at Rensselaer, N. Y., comprising one-story unit, 75 x 150 ft., and one-story addition to existing factory, 78 x 100 ft. Cost over $130,000 with equipment.

Prest-O-Lite Co., Inc., 30 East Forty-second Street, New York, manufacturer of gas cylinders for compressed and liquefied industrial gases, affiliated with Linde Air Products Co., same address, has let general contract to R. R. Richardson, Citizens' Bank Building, Norfolk, Va., for one-story branch plant near Twenty-fifth Street, Norfolk. Cost close to $100,000 with equipment.

Board of Education, City Hall, Yonkers, N. Y., plans manual training department in new group senior and junior high school at Valley Farms. Cost about $2,400,000. Financing is being arranged through Federal aid. A. G. Corbin, superintendent of buildings, address noted, will prepare plans.

American Carrier-Call Corp., 36 West Forty-fourth Street, New York, manufacturer of electrical appliances, radio equipment, etc., has arranged for stock issue of about $800,000, part of fund to be used for purchase of equipment, raw materials, etc.

Mathieson Alkali Works, Inc., 60 East Forty-second Street, New York, manufacturer of industrial chemicals, alkali specialties, etc., has let general contract to Wright & Kremers, Inc., Niagara Falls, N. Y., for one-story compressor building, and other expansion at plant at Niagara Falls. Cost close to $50,000 with equipment.

Faitoute Iron & Steel Co., 182 Frelinghuysen Avenue, Newark, N. J., has acquired tract of 36,000 sq. ft. near works for expansion, including one-story addition for storage and distribution. Cost over $45,000 with equipment.

Hoffman Beverage Co., 402 Grove Street, Newark, plans four-story and basement addition to brewery, primarily for storage and distribution. Cost close to $150,000 with equipment. Epple & Kahrs, 17 Washington Street, are architects and engineers.

Commanding Officer, Ordnance Department, Frankford Arsenal, Philadelphia, asks bids until Oct. 21 for one adjustable toolmaker's knee, and one set parallels (Circular 175), one comparator gage, bench type, combination of mechanical gaging with optical and mechanical magnification (Circular 172); until Oct. 22, one single-acting open-back press (Circular 166); until Oct. 26, 29,800 steel forgings for fuze plug holes, with alternate bids for 11,713 ft. carbon steel for fuze plug holes (Circular 145), 8300 steel windshields (Circular 146), 39,361 steel base plug forgings (Circular 136), 136 shell body forgings (Circular 141), furnishing and installing air-conditioning system in west end of building No. 40, and for room in building No. 45 (Circular 155).

Pennsylvania Power & Light Co., Allentown, Pa., plans extensions in transmission and distributing lines for rural electrification, totaling over 500 miles. Cost close to $600,000.

NEW ENGLAND

New Departure Mfg. Co., Bristol, Conn., manufacturer of ball bearings, steel balls, etc., has asked bids on general contract for one-story addition, about 50 x 110 ft. Cost over $40,000 with equipment.

Flintkote Co., Park Square Building, Boston, manufacturer of roofing, plans expansion at different plants to cost about $2,000,000, including equipment. Of this appropriation, close to $1,000,000 will be used for new mill at Los Angeles, to be operated by Pioneer-Flintkote Co., 5500 South Alameda Street, Vernon, Los Angeles, a subsidiary. Several extensions will be made in branch plant at East Rutherford, N. J., including additional facilities for production of automotive products, to cost $750,000. About $250,000 of fund is being used for new mill at Chicago Heights, Ill., now in course of erection.

Bureau of Supplies and Accounts, Navy Department, Washington, asks bids until Oct. 20 for one motor-driven abrasive wheel cut-off machine for Newport, R. I., Naval Station (Schedule 9017).

Commanding Officer, Ordnance Department, Springfield Armory, Springfield, Mass., asks bids until Oct. 20 for one automatic testing machine (Circular 51).

Sun Oil Co., 1608 Walnut Street, Philadelphia, plans bulk oil storage and distributing plant at East Hartford, Conn. Cost close to $50,000 with steel tanks and other equipment.

WASHINGTON DIST.

Quartermaster, Third Corps Area, Post Office Building, Baltimore, asks bids until Nov. 3 for 25 self-oiling gasoline engines (Proposal 53-11).

Glenn L. Martin Co., Middle River, Baltimore, manufacturer of airplanes and parts, will carry out expansion, including new buildings and equipment for parts production and assembling. Present capacity will be doubled. Company has arranged for sale of 350,000 shares of stock, totaling about $4,200,000, of which over $1,500,000 will be used for purpose noted.

General Purchasing Officer, Panama Canal, Washington, asks bids until Oct. 19 for 21,400 ft. of 1½ and 2¼-in. plow steel wire rope, phosphor bronze wire rope, galvanized malleable iron pipe fittings, galvanized iron tees, cast iron soil pipe fittings, 7000 lb. steel wire finishing nails, 5600 lb. common wire galvanized steel nails, 1500 lb. copper wire slating nails, 2000 lb. countersunk-head galvanized steel tram nails, 4000 lb. galvanized boat spikes, gate valves, globe valves and other equipment (Schedule 3186); until Oct. 20, 14,000 helical spring washers, 28,000 lb. carbon steel track bolts, spring frogs, switches and other equipment (Schedule 3188).

Maryland Bolt & Nut Co., Smith Avenue, Mount Washington, Baltimore, has let general contract to Engineering-Contracting Corp., North and Linden Avenues, for one-story addition, 45 x 110 ft. Cost over $40,000 with equipment.

Bureau of Supplies and Accounts, Navy Department, Washington, asks bids until Oct. 20 for one motor-driven universal tool and cutter grinder (Schedule 9018) for Quantico, Va., Naval Station; one woodworking machine, with ball bearing and built-in motor (Schedule 9020) for Portsmouth, Va., yard; three medium duty, motor-driven engine lathes, with spare parts and tools (Schedule 8977) for Portsmouth and Mare Island yards; until Oct. 23, 36 acetylene gas cylinders (Schedule 9037) for Portsmouth yard; nine motor-driven bench-type lathes (Schedule 9039) for Sewall's Point, Va., yard; two molding machines (Schedule 9043) for Norfolk, Va., yard; four mechanical single-shaft revolution counters (Schedule 8988) for Boston Navy Yard; electrically operated valves and spare parts (Schedule 9024) for Philadelphia yard; until Oct. 20, one hand-operated turret type punch (Schedule 8933) for Eastern or Western yard.

SOUTH ATLANTIC

Brunswick Pulp & Paper Co., Brunswick, Ga., recently organized as a subsidiary of Mead Corp., Chillicothe, Ohio, has acquired about 200 acres of marsh land near Brunswick, and will reclaim as site for new pulp and paper mill. About 40 acres will be used for initial units for pulp production and bleaching, including power house, machine shop and other mechanical structures. Cost over $1,500,000 with machinery. Later it is proposed to erect a paper-making unit on adjoining site. Entire project will cost in excess of $3,000,000.

Bureau of Supplies and Accounts, Navy Department, Washington, asks bids until Oct. 20 for one motor-driven woodworking machine for Pensacola, Fla., Naval Station (Schedule 9019).

Snapping Shoals Power & Light Co., Covington, Ga., asks bids until Oct. 26 for transmission and distributing lines for rural electrification in parts of Rockdale, Newton, Henry and Butts counties, totaling over 135 miles, with service facilities. Cost over $150,000. J. B. McCrary Engineering Corp., Atlanta, Ga., is consulting engineer.

WESTERN PA. DIST.

United States Engineer Office, Pittsburgh, asks bids until Oct. 22 for one diesel engine-driven electric generating set (Circular 111); until Oct. 26, two vertical triple single-acting power-driven pumping units with accessories (Circular 120).

Aluminum Co. of America, Inc., Gulf Building, Pittsburgh, has plans for extensions and improvements in reduction plant and sheet mill at Alcoa, Tenn., including one-story buildings and additional equipment. Cost over $100,000 with equipment. Structural steel award has been made to Fort Pitt Bridge Works Co.

Duquesne Brewing Co., South Twenty-second Street, Pittsburgh, has let general contract to C. H. Kerr Co., 120 South Oakland Avenue, for one-story and basement addition, 80 x 115 ft., primarily for mechanical-bottling department. Cost close to $75,000 with equipment. F. F. Bollinger Co., Duss Avenue, Ambridge, Pa., is architect.

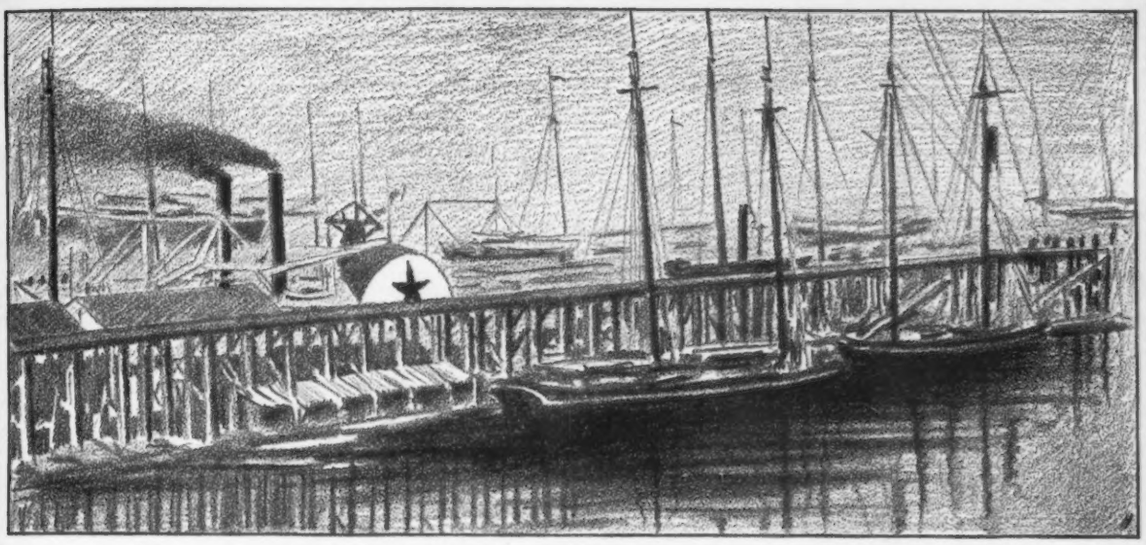
OHIO AND INDIANA

Weatherhead Co., 620 Frankfort Avenue, Cleveland, manufacturer of automobile parts, brass fittings and couplings and kindred products, has purchased part of former plant of Hupp Motor Car Corp., East 131st Street, consisting of a four-story structure and two one-story buildings. Present plant will be removed to new location and capacity increased.

Greaves Machine Tool Co., 2009 Eastern Avenue, Cincinnati, manufacturer of machine tools and parts, has let general contract to Austin Co., Cleveland, for two-story addition, 35 x 100 ft. Cost over $40,000 with equipment.

Clopay Corp., York Street, Cincinnati, manufacturer of paper products, has let general contract to Parkway Construction Co., Keith Building, for two-story and basement addition to paper-converting plant, 100 x 220 ft. Cost over $85,000 with

SINCE 1850



Marquette Harbor, in the late 1850's, was a maze of sailing vessels. An occasional side wheeler, the forerunner of the modern ore carriers, varied the monotony.

CLIFFS SHAFT LUMP ORE
FOR OPEN HEARTH FURNACES

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Lake Superior Iron Ores of All Grades

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COAL—Industrial . . . By Product . . . Domestic

THE CLEVELAND-CLIFFS IRON CO.

UNION TRUST BLDG. CCC CLEVELAND, OHIO

equipment. Carl J. Kiefer, Inc., Schmidt Building, is consulting engineer.

Efficient Tool & Die Co., 9314 Elizabeth Avenue, Cleveland, has plans for one-story addition, 80 x 80 ft. Installation will include a 5-ton traveling crane and craneway, and other mechanical-handling equipment. H. W. Maurer, 3126 Scarboro Street, is architect.

Columbia Electric Mfg. Co., 4519 Hamilton Avenue, Cleveland, manufacturer of electroplating generator units, electric alternators, parts, etc., has let general contract to J. L. Hunting Co., Ninth-Chester Building, for one-story addition, 60 x 250 ft., with extension 32 x 51 ft. Cost close to $100,000 with equipment. Christian, Schwarzenberg & Gaede, 1836 Euclid Avenue, are architects.

Contracting Officer, Material Division, Army Air Corps, Wright Field, Dayton, Ohio, asks bids until Oct. 19 for self-locking nuts (Circular 226); until Oct. 20, 150 fuel pump coupling shaft assemblies, 2800 fuel pump flexible shaft drives and 400 shaft assemblies (Circular 234), 146 2½-ton hydraulic jacks (Circular 230); until Oct. 21, 400 pressure landing gear-type gage assemblies (Circular 231), spur gears, motor and control equipment, transformers, connectors, jacks, resistors, condensers, sockets and other kindred equipment (Circular ARL-6); until Oct. 25, one disk grinder, one feed table, one plain table, four disk wheels and one set exhaust hoods (Circular ARL-9).

BUFFALO DISTRICT

Simonds Saw & Steel Co., Ohio Street, Lockport, N. Y., will take bids soon on revised plans for one-story foundry addition. Bids recently received have been rejected. Cost over $45,000 with equipment. Main offices are at Fitchburg, Mass.

Worthington Pump & Machinery Corp., Clinton and Roberts Streets, Buffalo, has filed plans for one-story foundry unit. Cost close to $75,000 with equipment.

Precision Casting Co., Inc., Fayetteville, Syracuse, N. Y., manufacturer of die castings, has let contract for structural steel framing for one-story addition to Syracuse Engineering Co., Everson Building. Cost about $40,000 with equipment.

MICHIGAN DISTRICT

Detroit, Toledo & Ironton Railroad Co., Dearborn, Detroit, plans new engine house and shop terminal at Flat Rock, Mich., including one-story machine and repair shops, storage and distributing buildings and other structures. Cost over $75,000 with equipment. Shreve, Anderson & Walker, Book Building, Detroit, are architects.

Ralston Purina Co., South McCamly Street, Battle Creek, Mich., manufacturer of food products, has plans for six-story addition, adjoining present two-unit plant. Cost over $600,000 with machinery. Main offices are at 835 South Eighth Street, St. Louis.

Chesaning Elevator Co., Chesaning, Mich., has let general contract to George Vasold, Freeland, Mich., for new grain elevator, to replace a unit recently destroyed by fire. Cost about $125,000 with elevating, conveying, screening and other equipment.

Detroit Steel Products Co., 2250 East Grand Boulevard, Detroit, manufacturer of steel sash and kindred products, has let general contract to J. A. Utley, Inc., 6031 Mansur Street, for one-story addition, about 23,000 sq. ft. floor space. Cost close to $80,000 with equipment.

SOUTH CENTRAL

United States Engineer Office, Vicksburg, Miss., asks bids until Oct. 23 for ball joints, complete with bolts, gaskets, etc. (Circular 86).

Kentucky Public Elevator Co., 1400 Gallagher Street, Louisville, has let general contract to James Stewart Corp., 343 South Dearborn Street, Chicago, for addition to grain elevator, comprising 40 tank units, each 21 ft. in diameter and 120 ft. high. Cost about $200,000 including elevating, conveying and other mechanical equipment; electrical installation is estimated to cost close to $50,000 of amount noted.

Coca-Cola Co., North Avenue, Atlanta, Ga., has approved plans for new branch plant at Clarksdale, Miss., one-story, 60 x 100 ft., for mechanical-bottling and other service, and steam power house. Cost over $50,000 with equipment.

Director of Purchases, Tennessee Valley Authority, Knoxville, Tenn., asks bids until Oct. 22 for electric cable for 1000 miles of lines for rural electrification in Tennessee Valley area, including conductor armor, splicing materials, tie wire conductor, etc.; until Oct. 23, 72 units of dogging equipment for intake gates for Pickwick Landing Dam, each dogging unit to consist of a heavy cast steel dog arranged to turn on fixed pin and operated by hand lever at intake gate level.

Carter Mfg. Co., Kansas Street, Memphis, Tenn., manufacturer of automobile trailers and parts, winches and kindred equipment, has acquired site for one-story addition, primarily for expansion in trailer division.

SOUTHWEST

Anheuser-Busch, Inc., 721 Pestalozzi Street, St. Louis, has let general contract to C. George Saenger, 3816 West Fillmore Street, for six-story addition to brewery, primarily for storage and distribution. Cost over $200,000 with equipment. Other expansion is contemplated in near future.

City Council, Belle, Mo., has authorized plans for municipal waterworks, including centrifugal pumping machinery for deep-well service and auxiliary equipment. George E. Wells, Inc., Security Building, St. Louis, is consulting engineer. Cost about $75,000 with machinery.

State Building Commission, State Capitol Building, Jefferson City, Mo., Edgar M. Eagan, executive secretary, has let general contract to Charles H. Schroeder Construction Co., 2806 North Grand Avenue, St. Louis, for two shop buildings, each one-story, 51 x 165 ft., at institution in Cole County. Cost over $75,000 with equipment. Charles A. Haskins, Finance Building, Kansas City, Mo., is general supervising engineer; George B. Franklin, Mutual Building, Kansas City, is architect.

Quartermaster, Fort D. A. Russell, Tex., asks bids until Oct. 20 for one 100,000-gal. elevated steel tank, with altitude valve and accessory equipment for post water distribution system (Proposal 550-6).

C. W. Murchison and Dudley S. Golding, First National Bank Building, Dallas, Tex., are at head of project to build an oil refinery near Sulphur Bluff, Tex., primarily for gasoline production from low gravity crude oil, to include tank storage and distributing facilities. Cost close to $125,000 with equipment.

MIDDLE WEST

Chicago Aluminum Castings Co., 2647 Ogden Street, Chicago, has asked bids on general contract for one-story addition. Cost close to $35,000 with equipment. Alfred S. Alschuler, 28 East Jackson Boulevard, is architect.

Binks Mfg. Co., 3114-40 Carroll Avenue, Chicago, manufacturer of spraying equipment, water-cooling equipment, etc., has let general contract to Nels A. Johnson, Chicago, for one-story addition, 50 x 100 ft. H. C. Franzen, 2311 North Parkside Avenue, is architect.

Seeger Refrigerator Co., 850 Arcade Street, St. Paul, Minn., has let general contract to George J. Grant Construction Co., 893 Como Avenue, for one-story addition, 155 x 375 ft., primarily for storage and distribution, with installation of a conveyer system, loaders and other mechanical-handling equipment. Cost about $100,000.

United States Engineer Office, Fort Peck, Mont., asks bids until Oct. 19 for bandsaws, cross-cut saws, hammers, axes, welded chain and other tools (Circular 173).

Falstaff Brewing Co., 3220 South Twenty-fifth Street, Omaha, Neb., has let general contract to H. W. Stitt, 8533 North Twenty-fourth Street, for one-story addition to brewery. Cost about $35,000 with equipment. H. A. Raapke, Brandeis Theater Building, is architect.

Clearing Machine Corp., 6499 West Sixty-fifth Street, Chicago, manufacturer of die-duplicating machinery and parts, presses and kindred machinery, has plans for one-story addition. A 10-ton traveling crane and other mechanical-handling equipment will be installed. Cost close to $50,000 with equipment.

Village Council, Farmington, Minn., plans municipal electric light and power plant. Cost about $120,000 with distributing lines. Financing is being arranged. Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, is consulting engineer.

Twin Disc Clutch Co., Racine, Wis., has taken five-year lease on 50,000 sq. ft. of shop space at Rockford, Ill., to accommodate expansion of tractor clutch department. Extension to main plant in Racine costing about $30,000 was completed recently.

Waukesha Motor Co., Waukesha, Wis., manufacturer of motor truck, tractor and industrial engines, has placed contracts for an extension, 66 x 154 ft., 21 ft. high, to main machine shop, as part of a $50,000 enlargement program.

Burlington Brass Works, Burlington, Wis., has plans by John Topzant, architect, 424 East Wells Street, Milwaukee, for one-story shop addition, 85 x 88 ft.

Bureau of Reclamation, Denver, asks bids until Oct. 16 for one 12-in. manually operated and four 24-in. electrically operated gate valves for installation at Dead Ox pumping station, Owyhee Project, Oregon-Idaho (Specifications 838-D); until Oct. 20, two ¾-cu. yd. dragline excavators, one ½-cu. yd. dragline excavator, two ¾-cu. yd. dragline buckets, two ½-cu. yd. dragline buckets, and two ½-cu. yd. clamshell buckets for Casper-Alcova Project, Wyo. (Specifications 841-D); until Oct. 21, one 70-hp. crawler tractor and one ½-cu. yd. truck-mounted power shovel, convertible to a ½-cu. yd. clamshell excavator for Boulder power plant, Boulder Canyon Project (Specifications 845-D).

PACIFIC COAST

Pittsburgh Plate Glass Co., paint and varnish division, 7412 Maie Avenue, Los Angeles, has let general contract to Rainey & MacIsaac, 6224 Stanford Avenue, for three additions to local plant, three stories, 45 x 60 ft., for production, and two one-story units, 115 x 180 ft., for storage and distribution. Cost over $100,000 with equipment. Albert C. Martin, Higgins Building, is architect.

Paraffine Companies, Inc., Emeryville, Cal., manufacturer of roofing and building papers, pipe coverings, etc., has let general contract to Barrett & Hilp, 918 Harrison Street, San Francisco, for one-story addition. Cost about $40,000 with equipment. Leland Rosener, 233 Sansome Street, San Francisco, is engineer. Main offices are at San Francisco.

Bureau of Supplies and Accounts, Navy Department, Washington, asks bids until Oct. 20 for one motor-driven cold header (Schedule 8970); until Oct. 23, one motor-driven woodworking lathe (Schedule 9000) for San Diego Naval Station; until Oct. 20, one motor-driven turret lathe (Schedule 8971) for Keyport, Wash., yard; one motor-driven bench lathe, without bench or cabinet (Schedule 8997), one motor-driven watchmaker's lathe (Schedule 8999), one universal bench miller, with motor, attachments and spare parts (Schedule 8998); until Oct. 23, one worm and shaft, and one worm wheel (Schedule 9014) for Puget Sound yard; one motor-driven watchmaker's lathe and spare parts (Schedule 9015) for San Pedro Naval Air Station.

Bureau of Reclamation, Denver, asks bids until Oct. 22 for one 40 x 44.5 ft. steel regulating gate, gate frame, metalwork for gate counter weight, and motor-driven gate hoist for installation in auxiliary spillway, Horse Mesa Dam, Salt River Project, Ariz. (Specification 699).

Board of Education, 1425 South San Pedro Street, Los Angeles, asks bids on general contract until Oct. 19 for one-story vocational shop building and other structures at Western District junior high school, West Eighteenth Street. Entire project will cost about $400,000. Sumner P. Hunt, Laughlin Building, is architect; E. L. Ellingwood is mechanical engineer.

FOREIGN

National Oil Refineries, Ltd., Llandarcy, Glamorgan, Wales, England, plans expansion and improvements, including several new operating units and equipment, primarily for increase in lubricating oil division. Cost about $500,000 with machinery. W. C. Mitchell is general manager.

Stewarts & Lloyds (Australia), Ltd., Mayfield, Newcastle, New South Wales, Australia, manufacturer of steel pipe, steel tubing and kindred products, has approved plans for group of one-story additions, for manufacture of seamless steel tubing up to 7 in. diameter, and for other pipe and tube specialties. Cost close to $2,000,000 with equipment.

Fuel & Chemical, Ltd., Regina, Sask., care of A. W. Ellison Fawkes, Moose Jaw, Sask., consulting engineer, plans new plant near Regina for production of fuel briquettes, using local lignite as raw material, to include power house and other mechanical divisions. Cost about $400,000 with machinery. A. Grant, C.E., Kitchener, Ont., will prepare plans.

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CHUCKS, STAYBOLT
CLAMPS, BOILERMAKERS
CLEANERS, FLUE
CONDUCTOR PIPE
COPPER
COUPLINGS, HOSE
CRAYONS, SOAPSTONE
CUTTERS, FLUE AND FLUE HOLE
DRILL RODS
EAVES TROUGH & FITTINGS
EXPANDERS, FLUE
FERRULES, COPPER
FLANGES, BOILER AND TANK
FLOOR PLATES
GALVANIZED SHEETS, BARS, BANDS, ETC.
HANDLES, HAMMER
HEADS, TANK AND FLANGE
HOISTS, HAND AND POWER
HOOPS
IRON, STAYBOLT
LUGS, BOILER, TANK AND SILO
MACHINERY, HAND AND POWER
MANHEAD PLATES AND FITTINGS
NAILS
PACKING
PLATE STEEL
PLUGS, FLUE
RAILS AND FITTINGS
REAMERS
RODS, DRILL
RODS, WELDING ALL KINDS
SHAFTING
SHEETS
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UNIFORM BLUE
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GALVANNEALED
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CORRUGATED
KEYSTONE COPPER BEARING
COPPER AND BRASS
SPRING STEEL, BAR AND SHEET
STAINLESS STEEL
STRIP STEEL, (C.R. and H.R.)
TEES
TIRES, RD. EDGE
TOOLS, HAND AND POWER FOR BOILER AND IRON WORKERS
TOOL STEEL, BAR AND SHEET
TROLLEYS
TUBES, BOILER
TURNBUCKLES
VALVES, BLOW OFF
WELDING RODS, AND WELDERS
WIRE, BLACK AND GALVANIZED
ZEES

SCULLY STEEL PRODUCTS COMPANY

Chicago Newark, N. J. St. Paul Cleveland
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UNITED STATES STEEL

JUST BETWEEN US TWO

Speak of the Devil

ONLY the other day we were marveling at the company with the free-wheeling name, *The Pennsylvania Company for Insurances on Lives and Granting Annuities,"* and what should pop in but a letter from the self-same P.C.f.I.o.L.a.G.A., asking for clippings of A. W. Bass, Jr.'s, Sept. 10 article, *"Evaluating Shop Jobs by the Point System."* One big company (not Westinghouse) ordered 3000 reprints for distribution among its executives. The second half of the article appeared last week. This is a four-star article—something for your book.

Blurb

THE No. 1 dial on the publisher's instrument board is the subscription renewal percentage, as it shows how the paper is registering with its readers.

Renewal figures for the first quarter are now ready.

	Expirations	*Renewals*	*Percentage*
January, 1936	1666	1374	82.4 per cent
February "	937	763	81.4 " "
March "	1050	855	81.3 " "
	3653	2992	81.7 per cent

Of course, you would expect The Iron Age to have the highest renewal percentage of any of the general metal-working papers. Otherwise, why should we mention it?

Attention—Grabbers

'GOODRICH Rubber 'Sings Mammy' to a Million Motherless Chicks."—The B. F. Goodrich Co.

"Jack of one *trade, and a* master *at it."*—Allegheny Steel Co.

"For Cranks on the Subject of Cranks."—Erie Foundry Co.

"What a Dyke is to the Dutch Hot Galvanizing is to Iron and Steel."—American Hot Dip Galvanizers Assn., Inc.

She Learned About Steel From Us

MRS. JEAN O'HAVER SHASSERE, of W. J. Holliday & Co., Chicago steel warehouse, writes:

> "When I started in 1920 I was absolutely new in the business . . . My company suggested that I read The Iron Age each week . . . Not only did I learn from the many worthwhile articles, but *I can truthfully say I learned more from the advertisements than I ever have learned from any text book on steel."*

Shoemaker Deserts Last

"A SIMPLE five-word slogan may hoist an obscurity to the heights almost over night . . .," says O. O. McIntyre, newspaper columnist. Probably "Odd" learned all that he knows about advertising from the stage plays. The hero nose-dives into anguished thought, runs fingers through hair, bites pencil, shouts "I have it!" and delivers the slogan that saves the business.

It never happens in real life, which is too bad, for slogan advertising was so comforting. Instead of wracking your brains thinking up reasons why people should buy your product you simply stuck the slogan in the center of a page and there you were.

But times have been hard for slogans since someone discovered that it didn't necessarily pay to give the slogan a lot of advertising and the business little. Not that we are opposed to slogans. We even have our own modest little gem, *"The World's Greatest Industrial Paper,"* which we expose to a breathless world every now and then, but less frequently since we discovered that a hat paper calls itself. *"The World's Greatest Hat Paper."*

Unmasked

"JOHN erased afford erected Marys hurt too infectious dead," the Scotch telegram printed here Sept. 17, has us in hot water. Bob (GE) Orth denies it is Scotch as it has only nine words.

Worse still, "Gess Hoo" of Los Angeles reveals that the original appeared in *Judge* several years ago, as a "Scotch-O-Gram:" "TOM DETAINED ERASED AFFORD ERECTOR ANALYSIS HURT INFECTIOUS IN HOSPITAL." "Gess Hoo" writes:

> "A magazine as highly esteemed as The Iron Age is reputed to be should make it a policy not to print jokes more than five years old. Please note the enclosed page from *Judge*, of Oct. 13, 1928. Now, when you begin to print jokes almost eight years old, that's going a little too far back. Don't you agree?"

No, we positively don't agree. After seven years, jokes are reborn and become brand new. We will overlook "Gess Hoo's" error, but what we positively cannot excuse is his successful search for the evidence. It isn't cricket. The man is a menace. Civilization will totter if this search for original sources continues. We demand an apology, and it better be abject. —A. H. D.